Submission
No 19

INQUIRY INTO PROTECTION OF THE ENVIRONMENT OPERATIONS AMENDMENT (CLEAN AIR) BILL 2021

Organisation: Environmental Justice Australia

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Submission

in response to

Inquiry into the Protection of the Environment Operations Amendment (Clean Air) Bill 2021

prepared by

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About Environmental Justice Australia

Environmental Justice Australia (formerly the Environment Defenders Office, Victoria) is a not-for-profit public interest legal practice. We are independent of government and corporate funding. Our legal team combines technical expertise and a practical understanding of the legal system to protect our environment.

We act as advisers and legal representatives to community-based environment groups, regional and state environmental organisations, and larger environmental NGOs, representing them in court when needed. We provide strategic and legal support to their campaigns to address climate change, protect nature and defend the rights of communities to a healthy environment.

We have been providing legal advice and representation to the community for over two decades on air pollution issues. We advocate for better air pollution laws at the state and federal level to protect the health of communities and the environment. Through our legal advice, law reform and community legal education services we provide support to the community to understand the health impacts from air pollution sources and how to best prevent them.

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https://www.parliament.nsw.gov.au/committees/inquiries/Pages/lodge-a-submission.aspx?pk=2812

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Introduction

Environmental Justice Australia welcomes the opportunity to provide a submission to the Legislative Council's Portfolio Committee No. 7 – Planning and Environment Inquiry (**Committee**) into the 'Protection of the Environment Operations Amendment (Clean Air) Bill 2021' (**Clean Air Bill**), which proposes to reform the *Protection of the Environment Operations Act 1997* (NSW) (**POEO Act**).

Coal-fired power stations are the single most significant controllable source of air pollution in New South Wales (**NSW**).[1] There is no level of air pollution at which exposure does not cause or contribute to adverse health impacts, including premature deaths.[2]

The regulation of air pollution from coal-fired power stations in NSW falls well below international standards. This is due to a number of factors.

First, the legislative regime does not include adequate emissions concentration standards (or 'limits') required to drive industry improvements, including the requirement to install best available pollution control technology (**BACT**).

Second, by virtue of the legislative regime, the NSW Environment Protection Authority (**EPA**) is not adequately empowered to require stronger emissions limits in the conditions of coal-fired power stations environment protection licences.

Third, statutory reform is inconsistent with the Legislature's apparent understanding of the gravity of the health impacts of air pollution[3] and the enormous annual AUD$1.4 billion cost of those impacts to the NSW economy.[4] Therefore, despite availing itself of the health costs of air pollution, the Government has so far ignored the necessary actions it must implement to address this major issue.

Environmental Justice Australia has been advocating for better regulation of air pollution from coal-fired power stations in NSW for six years. During this time, we have made numerous submissions to NSW Government processes in relation to air quality and air pollution. For example, in 2020 we made a submission to the NSW Legislative Council's Inquiry into the 'Health impacts of exposure to poor levels of air quality resulting from bushfires and drought'. Our submission, among other things, recommended that the Government minimise the overall impacts of air pollution on public health by setting stronger stack emission limits for coal-fired power stations in line with international standards. More recently, we made a submission on the Government's draft *Clean Air Strategy 2021-2030* (**Strategy**), outlining that a serious flaw of the draft Strategy is its failure to include actions designed to better regulate emissions from coal-fired power stations to protect communities from emissions between now and the eventual closure of coal-fired power stations. We proposed the

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[1] NSW Environment Protection Authority 'Air Emissions Inventory for the Greater Metropolitan Region in New South Wales 2013 Calendar Year' (October 2019) < https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/air/19p1917-air-emissions-inventory-2013.pdf?la=en&hash=9217ADF2C8D5647147FF00F447258319D00BB75D/> ; Environmental Justice Australia, *The People's Clean Air Action Plan for NSW* (Policy Paper, 2021) 7.
[2] Regional Office for Europe, World Health Organization, *Air Quality Guidelines: Global Update 2005* (Report, 2006).
[3] Evidence to Portfolio Committee No. 7 – Planning and Environment, NSW Legislative Council, Macquarie Street Sydney, 2 March 2021, 40-41 (The Hon. Matt Kean MP) <https://www.parliament.nsw.gov.au/lcdocs/transcripts/2524/Transcript%20-%20Tuesday%202%20March%202021%20-%20CORRECTED.pdf>.
[4] Australian Institute of Health and Welfare, *Australian Burden of Disease Study: Impact and Causes of Illness and Death in Australia 2011* (Study Series No 3, 10 May 2016); Stephen Begg et al, *The Burden of Disease and Injury in Australia 2003* (Report, May 2007); Access Economics, *The Health of Nations: The Value of a Statistical Life* (Research Report, July 2008).

Government adopt actions such as those in *The People's Clean Air Action Plan for NSW*[5] – a policy paper we prepared to identify those actions the Government must take to minimise the health impacts of the largest controllable sources of area pollution in NSW. The *People's Clean Air Action Plan for NSW* is annexed to this submission as **Annexure A**.

Despite our advocacy, considerable input from community and health experts, and scientific consensus on the life altering health impacts of air pollution, consecutive Government processes have failed to keep NSW communities safe from air pollution from coal-fired power stations.

Since their introduction, there have been no substantive amendments to the POEO Act or the *Protection of the Environment Operations (Clean Air) Regulation 2010* (**Clean Air Regulation**) to reduce the standards of concentration for nitrogen dioxide (NO_2) or nitric oxide (NO) or both as NO_2 equivalent (collectively, **nitrogen oxides**) and solid particles (Total) applicable to coal-fired power stations. Furthermore, there are no prescribed standards for sulphur dioxide and mercury in NSW environment protection legislation for electricity generating coal-fired power stations.

NSW communities deserve ambitious air pollution standards that are focused on improving the health benefits from regulation of air emissions. We therefore welcome the opportunity to comment specifically on the proposed Clean Air Bill as a means to addressing the current legislative deficiencies and failures of the regulatory regime with respect to air pollution.

We note that the Terms of Reference for this Inquiry are broad. Our submission therefore comments on all aspects of the Clean Air Bill and relevant related air pollution evidence and policy.

Environmental Justice Australia supports the proposed Clean Air Bill and makes the following recommendations:

1. that the Committee support the Clean Air Bill to facilitate it being commended to the House;
2. that the Committee consider the proposed amendments to the Clean Air Bill contained in **Annexure B**;
3. that the Committee seek to establish a clear timeline of operators' existing and projected major refurbishment dates and commitments to help inform when the installation of BACT at each coal-fired power station is achievable by;
4. that the Committee seek further information from operators as to the estimated cost of installing BACT at each coal-fired power station based on its site-specific design and inquire into the engineering characteristics of each NSW coal-fired power station;
5. that the Committee establish an independent panel of experts to review the engineering characteristics of NSW coal-fired power stations and advise on retrofitting the power stations with BACT; and
6. that the Committee consider all avenues for driving down air pollution, such as the NSW Load Based Licencing Scheme, in addition to legislative amendment.

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[5] Environmental Justice Australia, above n 1.

1. Regulatory background

1.1 Current regulation of air pollution from coal-fired power stations in NSW

Air quality is determined by standards set for ambient air quality and standards set for point-source emissions. Ambient air refers to outdoor air around us at any given moment. Point source emissions refer to air pollution emitted from a specific source, such as a coal-fired power station stack.

The number of point-source emissions in a geographical region determines the general quality of the air and, as a result, the impact on communities. The stricter that point-sources of air pollution are controlled, the better ambient air quality is.

In NSW, point-source air emissions from coal-fired power stations are regulated through the setting of maximum emission limits, together with a licencing system for individual premises. The principal regulatory instrument is the POEO Act, supported by the Clean Air Regulation, which sets maximum emission limits. The *Protection of the Environment Operations (General) Regulation 2009* (NSW) provides for load-based licensing.

Part 5.4 of the POEO Act (sections 124–135) deals specifically with air pollution.

This includes the general obligation that the occupiers of non-residential premises do not cause air pollution by failing to operate or maintain plant, carry out work or deal with materials in a proper and efficient manner.[6]

Section 128 of the POEO Act requires occupiers of non-residential premises, such as coal-fired power stations, to comply with any air emission standards prescribed by regulations. Specifically, coal-fired power stations must comply with emission standards set in Schedule 3 of the Clean Air Regulation. Even where standards for a particular air impurity are not prescribed by regulation, occupiers must still take all practicable means to prevent or minimise air pollution.

The POEO Act requires that environment protection licences apply to coal-fired power stations, which include standards additional to, or more stringent than, those specified in the Clean Air Regulation.[7]

Part 5 of the Clean Air Regulation provides for standards of concentration of pollutants for coal-fired power stations based on the age of the power station,[8] as well as a process for reviewing the standards that apply to older power stations.[9] Under the Clean Air Regulation, standards for coal-fired power stations differ according to the 'Grouping' of the power station. Coal-fired power stations deemed to belong to a Group according to the age that they were commissioned. Group 1 coal-fired power stations are the oldest and Group 6 the newest.[10]

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[6] *Protection of the Environment Operations Act 1997* (NSW) ss 124-126.
[7] Ibid s 58.
[8] *Protection of the Environment Operations (Clean Air) Regulation 2010* (NSW) cl 38(1)(b), sch 3.
[9] Ibid cll 36-37.
[10] Ibid cl 32.

The Clean Air Regulation prescribes more stringent standards for newer coal-fired power stations. Tables 1 and 2 below summarise the Grouping of each NSW coal-fired power station and the standards of concentration prescribed in the Clean Air Regulation that apply to each Group.[11]

Table 1: Clean Air Regulation groupings for NSW coal fired power stations

Station	EPL No.	Commission Date	POEO Grouping
Mount Piper	13007	1993	Group 4
Eraring	1429	1982	Group 3
Bayswater	779	1985-1986	Group 3
Vales Point	761	1978	Group 5*
Liddell	2122	1971-1973	Group 5*

* In accordance with clause 35 of the Clean Air Regulation, coal-fired power station that prior to 1 January 2012, belonged to Group 2 (including any coal-fired power station previously in Group 1) is taken to belong to Group 5. In accordance with clause 35 Liddell and Vales Point were granted an exemption from Group 5 for the emission of nitrogen oxides.

Table 2: Clean Air Regulation prescribed standards of concentration

Air impurity	Standard of concentration (mg/m^3)	
Solid particles (Total)	Group 1	400
	Group 2, 3 or 4	250
	Group 5	100
	Group 6	50
Nitrogen dioxide (NO_2) or nitric oxide (NO) or both, as NO_2 equivalent	Group 1, 2, 3 or 4	2,500
	Group 5	800
	Group 6	500

As noted beneath Table 1, the Clean Air Regulation allows for coal-fired power station operators to apply for exemptions from the prescribed standards.[12] We consider this to be a key weakness of NSW air pollution legislation and expand on this further in section 1.2 below.

Table 2 does not include standards of concentration for mercury or sulfur dioxide. This is because the Clean Air Regulation does not prescribe standards for these pollutants and they are instead regulated directly by the environment protection licence that apply to each coal-fired power station.

Under section 58 of the POEO Act, the EPA has a broad discretion to vary the conditions of an environmental protection licence. The discretion includes the ability to require more stringent emissions limits for solid particles and nitrogen oxides than those prescribed in the Clean Air

[11]Ibid sch 3.
[12] Ibid cl 35.

Regulation. Table 3 below, outlines the current licenced point source emission limits that apply to each coal-fired power station.

Table 3: Licenced point source emission limits for each NSW coal-fired power station

	Solid particles (mg/m^3)	Nitrogen oxides (mg/m^3)	Mercury (mg/m^3)	Sulfur dioxide (mg/m^3)
Mount Piper (Group 4)	50	1500	0.05	1700
Eraring (Group 3)	50	1100	0.05	1700
Bayswater (Group 3)	50	1500	0.05	1700
Vales Point (Group 5*)	50	1500	0.05	1700
Liddell (Group 5*)	50	1500	0.05	1900

The EPA has imposed a stricter emission limit for solid particles of $50mg/m^3$ than would otherwise apply under the Clean Air Regulation for all of the coal-fired power stations. Similarly, the nitrogen oxides emission limit of $1500mg/m^3$ is stricter than the limit of $2500mg/m^3$ prescribed for Group 1, 2, 3 or 4 coal-fired power stations in the Clean Air Regulation.

That the EPA has used its discretion to impose stricter emission limits than prescribed by the Clean Air Regulation should not be a cause for celebration however, as the limits still do not safeguard human health nor require installation of BACT, as discussed below in section 4.1. In other words, the fact that the EPA can prescribe stricter limits without the power stations having to do anything to reduce their emissions demonstrates the self-evident inadequacy of the Clean Air Regulation to protect human health.

The standards set in the Clean Air Regulation are redundant as a tool to drive down air pollution from coal-fired power stations. This is because they act as the benchmark that tougher standards are measured against. As a modicum, they are too high. Consequently, the EPA is 'hamstrung' in its ability to justify and impose more stringent, health-based standards that differ substantially from what is currently legislated.

The Clean Air Bill proposes to specify standards of concentration for air pollutants from coal-fired power stations in the POEO Act itself, as opposed to the Clean Air Regulation. Its enactment would empower the EPA to regulate air pollution based on limits that are better designed to protect human health.

1.2 Exemptions to emission limits under the Clean Air Regulation

The Clean Air Regulation contains 'grandfathering' provisions aimed at ensuring the use of old technology and processes are phased out and do not cause environmental harm. Under the Clean Air Regulation, from 2012 any Group 2 coal-fired power station is taken to belong to Group 5.[13] This grandfathering approach is designed to ensure that older coal-fired power stations in Group 1 and

[13] Ibid cl 35(1).

Group 2 are required to plan equipment upgrades and replacements to facilitate emissions reductions, because they expectantly use older technology that generates higher emissions.[14]

However the Clean Air Regulation also provides for exemptions from this grandfathering approach and licensees of Group 2 coal-fired power stations can apply to be exempt from Group 5 emission limits.[15] Once granted, an exemption lasts for five years and a licensee can apply to have the exemption extended.[16]

Since 2012, Delta Electricity (**Delta**), as the licensee of Vales Point Power Station, has enjoyed an exemption from stricter Group 5 emission limits for nitrogen oxides. That is, Delta is not required to comply with the Group 5 nitrogen oxides emission limit of 800mg/m^3 and instead can pollute up to 1500mg/m^3. Delta has been granted two exemptions by the EPA. It applied for its third five-year exemption in December 2020. If granted, it will exempt Delta from tougher nitrogen oxides emission standards under the Clean Air Regulation until 2027. Effectively, by being exempt from the grandfathering provisions over the past decade, Vales Point has avoided having to substantially improve its pollution control technology as it has aged and circumvented the intent of the Clean Air Regulation.

This aspect of the legislation has enabled coal-fired power station operators such as Delta to avoid the requirements of the Clean Air Regulation to invest in better pollution control technology. The proposed Clean Air Bill would ensure that all coal-fired power stations are required to meet emissions standards that are consistent with international standards for existing coal-fired power stations.

1.3 Failure of laws to change with health evidence

The body of domestic evidence for health impacts associated with air pollution has increased markedly since air quality and emissions standards were first set. Air pollution laws have not kept pace with this evidence.

In 1997, the *Clean Air (Plant and Equipment) Regulation 1997* (NSW) (**Plant and Equipment Regulation**) commenced operation and remade provisions of the *Clean Air Regulations 1964* (NSW). Relevantly, the Plant and Equipment Regulation repealed provisions of *Clean Air Regulations 1964* in relation to plant and equipment (which include coal-fired power stations) and established the basis of the Grouping provisions and emission limits now contained in the Clean Air Regulation. The Plant and Equipment Regulation:

- set point source emission limits for pollutants from scheduled premises involving 'fuel burning equipment' based on when a premises became a scheduled premises or when pollution control approval was made;[17]

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[14] Department of Environment and Conservation NSW, *Frequently Asked Questions: Protection of the Environment Operations (Clean Air) Regulation 2002 Part 4: Emission of Air Impurities from Activities and Plant* (Guide, August 2006) 10–12.
[15] *Protection of the Environment Operations (Clean Air) Regulation 2010* (NSW) cl 35(2).
[16] Ibid cll 35(3)(b) and 35(4).
[17] *Clean Air (Plant and Equipment) Regulation 1997* (NSW) cl 11.

- prescribed maximum emission limits for nitrogen oxides for fuel burning equipment of:
  - 2500mg/m^3 for premises commissioned before 1 August 1997; and[18]
  - 800mg/m^3 for premises commissioned after 1 August 1997; [19]
- prescribed maximum emission limits for solid particles for fuel burning equipment of:
  - 400mg/m^3 for premises commissioned before 1 January 1972;[20]
  - 250mg/m^3 for premises commissioned after 1 January 1972;[21] and
  - 100mg/m^3 for premises commissioned after 1 August 1997.[22]

The Clean Air Regulation contains the same emissions standards that were set for Groups 1-5 in the Plant and Equipment Regulation. That is, they have not been revised since their introduction nearly 25 years ago.

The Plant and Equipment Regulation was repealed by the *Protection of the Environment Operations (Clean Air) Regulation 2002* (**Clean Air Regulation 2002**). In 2005, the Clean Air Regulation 2002 was amended and new provisions in relation to activities and the operation of plant and equipment came into effect, including the introduction of 'Group 6' emission limits and the effective replacement of Group 1 and 2 emission standards with Group 5 standards from 1 January 2012.[23] This meant coal-fired power stations in Groups 1 and 2 were required to meet the Group 5 standards or seek an exemption, which was apparently justified on the following basis:

> *For many operators of affected equipment, the requirements should only involve demonstrating that their equipment already meets the Group 5 standards. For others there may be a need to plan equipment upgrades, although much of the equipment affected is likely to be near the end of its economic life cycle and due for major maintenance or replacement anyway.*[24]

The above extract indicates that the 2005 amendments were in part designed to ensure that aging equipment continues to meet contemporary emission standards.

Notably, the Group 6 emission limits set for coal-fired power stations in 2005 are the same as those we now see in the Clean Air Regulation.

Whilst regulations have progressively created new 'Groups' and tightened emission limits over time, the granting of exemptions have mostly prevented any significant improvement of emissions from coal-fired power stations. Further, government has failed to make law and set policy at the rate

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[18] Ibid cl 11(1)-(3) and Table A and Table B.
[19] Ibid cl 11(4)(b) and Table C.
[20] Ibid cl 13(1)-(2) and Table A.
[21] Ibid cl 13(3) and Table B.
[22] Ibid cl 13(4) and Table C.
[23] Department of Environment and Conservation NSW, above n 14, 10–13.
[24] Ibid 11.

needed to protect human health. By stepping through the history of amendments to emission limits in the regulations, it is evident that:

1. emission limits have not significantly reduced in line with health evidence, especially over the past 15 years (this is despite a whole of regulation remake in 2010);[25]
2. the Clean Air Regulation is not doing what it was intended to do with respect to the gradual upgrading of older coal-fired power stations. This is particularly evident with respect to the ability for operators to apply for multiple exemptions from the Clean Air Regulation, as explained in section 1.2 above.

Environmental Justice Australia has sought to obtain a copy of the Regulatory Impacts Statement for both the Plant and Equipment Regulation and Clean Air Regulation 2002 from the EPA. Should we obtain these documents within a timeframe to be of use to the Inquiry, we may seek to make a supplementary submission with respect to these.

2. Health impacts of air pollution

2.1 Pollutants of most concern

Burning coal for electricity generation emits a broad range of pollutants that impact health. The Clean Air Bill addresses four key pollutants released or formed in the atmosphere from coal-fired power stations: fine particle pollution ($PM_{2.5}$) and coarse particle pollution (PM_{10}) (collectively, 'solid particles'), nitrogen oxides, sulfur dioxide and mercury.

Particle pollution consists of tiny solid particles that come in a range of sizes, measured in micrometres. Coarse particle pollution (**PM_{10}**) is particle size of 10 micrometres (**µg**) in diameter, which generally forms as dust (such as coal dust) and is inhalable into the lungs. Fine particle pollution (**$PM_{2.5}$**), is much smaller at 2.5µg in diameter. Its small size means it can get deeper into the lungs and into the bloodstream, causing a range of serious health impacts, many of which can ultimately lead to premature death.

Nitrogen oxides and sulfur dioxide are gases that are formed during the process of combustion. In addition to being toxic of their own accord, both nitrogen oxides and sulfur dioxide form secondary $PM_{2.5}$,[26] creating an additional huge quantities of toxic fine particle pollution. In addition to improving reduction of $PM_{2.5}$ emissions from industrial sources, strict control measures to drive down nitrogen oxides and sulfur dioxide emissions must be installed to reduce the creation of secondary $PM_{2.5}$. Nitrogen dioxide is the main oxide of nitrogen pollutant of concern.

Mercury is a well-known and potent neurotoxin. Although mercury is released in lower levels than solid particles, nitrogen oxides and sulphur dioxide, it is highly toxic and accumulates in both the

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[25] Under the *Subordinate Legislation Act 1989* (NSW), the *Protection of the Environment (Clean Air) Regulation 2002* (NSW) was repealed on 1 September 2010 and was remade with limited changes as the *Protection of the Environment (Clean Air) Regulation 2010* (NSW).
[26] Ben Ewald, *The Health Burden of Fine Particle Pollution from Electricity Generation in NSW* (Report, November 2018) 20.

environment and organisms. The WHO considers mercury to be one of the top ten chemicals of major public health concern.[27] Coal burning is a key source of mercury discharge into the environment globally.[28]

Mercury emitted to air from coal-fired power stations is primarily made up of elemental mercury in different forms. It is not readily adsorbed to water, so is less likely to be deposited by rainfall and can therefore remain in the ambient air for over a year.

'Organic mercury', or methylmercury, refers to compounds containing both mercury and carbon atoms. It is not emitted to air from coal-fired power stations, but forms when mercury is deposited in waterways (either direct from air or as runoff) and is converted into methylmercury by microorganisms in sediment. Methylmercury bio accumulates and is considered the most poisonous form of mercury. Once in the environment, mercury is a persistent pollutant. It does not usually arrive in the human body directly but rather through ingestion of contaminated food, particularly seafood.

2.2 Health impacts

The International Agency for Research on Cancer classifies air pollution as a human carcinogen.[29] A 2019 global review of evidence found that air pollution has the potential to damage every organ and every cell in the human body.[30] In 2018, the director general of the WHO declared air pollution a "public health emergency".[31] Children and older people are most vulnerable to the health impacts of air pollution.

The most dangerous form of air pollution is $PM_{2.5}$. There is abundant evidence that $PM_{2.5}$ exposure can cause adverse health effects and increased risk of death.[32] There is no lower threshold for these effects.[33] The science does not support a safe level of exposure. Consequently air quality standards and emission limits are a reference level, not a safe level.[34]

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27 'Mercury and Health', *World Health Organization* (Fact Sheet, 31 March 2017) <https://www.who.int/en/news-room/fact-sheets/detail/mercury-and-health>.

28 United Nations Environment Programme, *Global Mercury Assessment 2013: Sources, Emissions, Releases and Environmental Transport* (Report, 2013).

29 World Health Organization, 'IARC: Outdoor Air Pollution a Leading Environmental Cause of Cancer Deaths' (Press Release No 221, 17 October 2013).

30 Dean E Schraufnagel et al, 'Air Pollution and Noncommunicable Diseases: A Review by the Forum of International Respiratory Societies' Environmental Committee, Part 1' (2019) 155(2) *Chest* 409; Dean E Schraufnagel et al, Air Pollution and Noncommunicable Diseases: A Review by the Forum of International Respiratory Societies' Environmental Committee, Part 2' (2019) 155(2) *Chest* 417.

31 Tedros Adhanom Ghebreyesus, 'Air Pollution is the New Tobacco. Time to Tackle this Epidemic', *The Guardian* (online, 27 October 2018) <https://www.theguardian.com/commentisfree/2018/oct/27/air-pollution-is-the-new-tobacco-time-to-tackle-this-epidemic>.

32 Douglas W Dockery et al, 'An Association between Air Pollution and Mortality in Six US Cities' (1993) 329(24) *The New England Journal of Medicine* 1753; D Krewski et al, 'Reanalysis of the Harvard Six Cities Study, Part I: Validation and Replication' (2005) 17(7–8) *Inhalation Toxicology* 335.

33 Ibid.

34 Regional Office for Europe, World Health Organization, *Air Quality Guidelines: Global Update 2005* (Report, 2006).

Long term exposure is particularly damaging, even at lower levels of pollution. A recent study from Queensland found that long-term exposure to $PM_{2.5}$ was associated with increased all-cause mortality of two percent for each 1 µg/m^3 increase in annual $PM_{2.5}$, even where $PM_{2.5}$ levels were measured well-below air quality standards.[35]

Research led by the University of Sydney has found up to a four percent increased risk of out-of-hospital cardiac arrest (**OHCA**) associated with every 10 µg/m^3 increase in $PM_{2.5}$.[36] OHCA is a major medical emergency, with less than one in 10 people worldwide surviving these events.[37]

In 2019, the Harvard Chan School of Public Health published an analysis of more than 95 million hospital insurance claims for adults aged 65 or older in the United States from 2000 to 2012.[38] The researchers found that each 1 µg/m^3 increase in $PM_{2.5}$ was associated with 2,050 extra hospital admissions, 12,216 days in hospital, and USD$31m in healthcare costs for diseases not previously associated with $PM_{2.5}$ including sepsis, kidney failure, and urinary tract and skin infections. These associations remained even at daily $PM_{2.5}$ concentrations below the WHO guideline. As such, the researchers concluded that substantial health and economic costs were linked to small $PM_{2.5}$ short-term increases.

Children are particularly vulnerable to $PM_{2.5}$ exposure due to the adverse effects on lung development. Australia's most common cause of general practitioner presentation in children under five is asthma and allergy. Reduced lung health and impaired development in children holds lifelong consequences, including an increased risk of cardiovascular disease and associated mortality as an adult.[39]

$PM_{2.5}$ is not the only pollutant that adversely impacts health. At low concentrations, nitrogen oxides and sulphur dioxide can cause significant health problems. A number of Australian studies published in the last decade demonstrate statistically significant health impacts at pollutant concentrations well-below national standards for these pollutants.[40] Nitrogen dioxide is strongly associated with childhood asthma and impaired lung development, which can lead to lifelong adverse health effects and premature death.[41] Adverse neonatal outcomes, including preterm birth, low weight at birth and

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35 Wenhua Yu et al, 'The Association between Long-Term Exposure to Low-Level $PM_{2.5}$ and Mortality in the State of Queensland, Australia: A Modelling Study with the Difference-in-Differences Approach' (2020) 17(6) *PLoS Medicine* e1003141:1–17.

36 Bing Zhao et al, 'Short-Term Exposure to Ambien Fine Particulate Matter and Out-of-Hospital Cardiac Arrest: A Nationwide Case-Crossover Study in Japan' (2020) 4(1) *Lancet Planet Health* 15.

37 University of Sydney, 'Air Pollution Impacts Can be Heart-Stopping: Biggest Study of Dangerously Small Particulate Matter and Cardiac Arrest', *ScienceDaily* (online, 28 January 2020) <https://www.sciencedaily.com/releases/2020/01/200128115421.htm>.

38 Yaguang Wei et al, 'Short Term Exposure to Fine Particulate Matter and Hospital Admission Risks and Costs in the Medicare Population: Time Stratified, Case Crossover Study' (2019) 367 *BMJ* l6258:1–13.

39 G Ryan et al, 'Decline in Lung Function and Mortality: The Busselton Health Study' (1999) 53(4) *Journal of Epidemiology and Community Health* 230; Vasiliki V Georgiopoulou et al, Lung Function and Risk for Heart Failure among Older Adults (2011) 124(4) *American Journal of Medicine* 334.; Don D Sin, LieLing Wu and S F Paul Man, 'The Relationship Between Reduced Lung Function and Cardiovascular Mortality: A Population-Based Study and a Systematic Review of the Literature' (2005) 127(6) *Chest* 1952.

40 Clare Walter et al, *Health-Based Standards for Australian Regulated Thresholds of Nitrogen Dioxide, Sulfur Dioxide and Ozone* (Expert Position Statement, 2019) 6–7.

41 Luke D Knibbs et al, 'The Australian Child Health and Air Pollution Study (ACHAPS): A National Population-Based Cross-Sectional Study of Long-Term Exposure to Outdoor Air Pollution, Asthma, and Lung Function' (2018) 120 *Environment*

foetal growth restriction are associated with maternal exposures to nitrogen dioxide and sulphur dioxide.[42] Middle-aged Australians exposed to nitrogen dioxide can experience exacerbations of current asthma, the incidence of new asthma, and atopy.[43] Long term exposure to sulphur dioxide, even at low concentrations, has been associated with cardiorespiratory mortality.[44]

Elemental mercury is toxic as a vapour if inhaled in high quantities, or more relevantly in lower quantities through chronic exposure. It can cause tremors, emotional changes such as irritability and mood swings, insomnia, neuromuscular changes, headaches, and cognitive difficulties.[45] The WHO has estimated a tolerable concentration of 0.2 $\mu g/m^3$ for long-term inhalation exposure to elemental mercury vapour, and a tolerable intake of total mercury of 2 µg/kg body weight per day.[46]

Methylmercury is a potent neurotoxin, particularly to developing foetuses, as it can pass though both the blood-brain barrier and the placenta. Children exposed to methylmercury in utero can experience lifelong IQ and motor-function deficits. Health impacts to adults from exposure to methylmercury include cardiovascular damage, endocrine disruption, diabetes risk, compromised immune function, and death.[47] Methylmercury is also toxic to mammals, fish, and birds. It is not readily excreted and bio accumulates and is biomagnified up the food chain. Therefore, animals at the top of the food chain (including humans) are at much greater risk of methylmercury poisoning.

In 2020, a health impact assessment of coal-fired power stations in NSW found that they contribute to approximately 450 babies being born with low birth-weight, 7,582 asthma symptoms in children and young adults and 477 premature deaths each year (**Farrow et al 2020 Report**).[48]

The NSW Government's draft *Clean Air Strategy 2021-30* also acknowledges that human-made air pollution shortens the lives of people in New South Wales.[49] It relies on a study by Broome et al.

International 394; Gayan Bowatte et al, 'Traffic Related Air Pollution and Development and Persistence of Asthma and Low Lung Function' (2018) 113 *Environment International* 170; W James Gauderman et al, 'Association of Improved Air Quality with Lung Development in Children' (2015) 372(10) *The New England Journal of Medicine* 905.

[42] Gongbo Chen, 'Exposure to Low Concentrations of Air Pollutants and Adverse Birth Outcomes in Brisbane, Australia, 2003–2013' (2013) 622–3 *Science of the Total Environment* 721; Shanshan Li, Yuming Guo and Gail Williams, 'Acute Impact of Hourly Ambient Air Pollution on Preterm Birth' (2016) 124(10) *Environmental Health Perspectives* 1623; Gavin Pereira et al, 'Locally Derived Traffic-Related Air Pollution and Fetal Growth Restriction: A Retrospective Cohort Study' (2012) 69(11) *Occupational and Environmental Medicine* 815.

[43] Gayan Bowatte et al, 'Traffic Related Air Pollution and Development and Persistence of Asthma and Low Lung Function' (2018) 113 *Environment International* 170; Gayan Bowatte et al, 'Traffic Related Air Pollution Exposure is Associated with Allergic Sensitization, Asthma, and Poor Lung Function in Middle Age' (2017) 139(1) *The Journal of Allergy and Clinical Immunology* 122.

[44] Xiao Yu Wang, Wenbiao Hu and Shilu Tong, 'Long-Term Exposure to Gaseous Air Pollutants and Cardio-Respiratory Mortality in Brisbane, Australia' (2009) 3(2) *Geospatial Health* 257.

[45] 'Health Effects of Exposure to Mercury', *United States Environmental Protection Agency* (Web Page, 3 March 2021) <https://www.epa.gov/mercury/health-effects-exposures-mercury>.

[46] World Health Organization 'Preventing Disease through Healthy Environments: Exposure to Mercury' (Document, 2007) 3.

[47] Harvard Chan C-CHANGE, 'Mercury Matters 2020: A Science Brief for Journalists', *Harvard TH Chan School of Public Health* (Web Page, 17 April 2020) <https://www.hsph.harvard.edu/c-change/news/mercury-matters-2020-a-science-brief-for-journalists/>.

[48] Aidan Farrow, Andreas Anhäuser and Lauri Myllyvirta, *Lethal Power: How Burning Coal is Killing People in Australia* (Report, August 2020) 22, 24.

[49] Department of Planning, Industry and Environment (NSW), *NSW Clean Air Strategy 2021–30: Draft for Consultation* (Report, March 2021) 5.

(2020) to posit that $PM_{2.5}$ pollution causes 420 premature deaths in the NSW Greater Metropolitan Region.[50]

2.3 Who is impacted

In the most recent assessment of air pollution from coal-fired power stations,[51] international air quality modelling experts conducted industry-standard air modelling. This modelling showed that air pollution from coal-fired power stations travels far beyond a coal-fired power station's location. Communities near the coal-fired power station may be exposed to the highest concentrations of air pollution under certain weather conditions,[52] but transport of $PM_{2.5}$ can extend for hundreds of kilometres and affect large populations in cities.[53] The assessment shows that, depending on wind direction and speed, $PM_{2.5}$ pollution from coal-fired power stations in NSW travels across an enormous geographical area, contributing to poor air quality in Sydney, northwards towards Lismore and into South-East Queensland, and as far down as Shepparton in Victoria.[54]

The highest concentrations of nitrogen dioxide air pollution from coal-fired power stations is in the air shed where the power station is located. Not only does the pollution travel far, it is most concentrated at the source, disproportionally exposing people in nearby communities.

3. Costs associated with air pollution

3.1 Cost of health impacts

As the most populous State, reducing air pollution in NSW and lifting the health burden for our communities should be a priority.

In 2005 the annual health cost of air pollution in the Sydney Greater Metropolitan Region was estimated to be $893 per head of population or approximately $4.7 billion,[55] equating to an estimated $6.4 billion a year in 2015 terms.[56] The Government's draft *Clean Air Strategy 2021-30* adopts an air pollution health cost figure of $3.3 billion,[57] based on a Broome et al study, which found 420 deaths attributable to air pollution in the NSW Greater Metropolitan Region.[58]

In 2009, the cost of burning coal on the health system in Australia was assessed to be over $2 billion every year.[59] In 2020, using the health impacts figures from the Farrow et al 2020 Report, a team of volunteer actuaries estimated the health cost to the Australian economy from coal-fired power

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[50] Richard A Broome et al, 'The Mortality Effect of $PM_{2.5}$ Sources in the Greater Metropolitan Region of Sydney, Australia' (2020) 137 *Environment International* 105429:1–9.
[51] Aidan Farrow, Andreas Anhäuser and Lauri Myllyvirta, above n 48.
[52] Ibid 5.
[53] Ibid.
[54] Ibid 18–19.
[55] Department of Environment and Conservation (NSW), *Air Pollution Economics: Health Costs of Air Pollution in the Greater Sydney Metropolitan Region* (Report, November 2005).
[56] NSW Environment Protection Authority and Office of Environment and Heritage, *Clean Air for NSW* (Consultation Paper, October 2016).
[57] Department of Planning, Industry and Environment (NSW), above n 49, 5.
[58] R A Broome et al, above n 50, 5-6.
[59] Tom Biegler, Australian Academy of Technological Sciences and Engineering, *The Hidden Costs of Electricity: Externalities of Power Generation in Australia* (Report, March 2009) 49.

stations to be $2.423 billion (**Johnson et al 2020 Report**).[60] This was based on the estimated Australia-wide extra 845 low birth-weight births, 14,434 person-days of asthma symptoms for 5-19 year olds and 785 premature deaths attributable to nitrogen oxides, sulfur dioxide and solid particle pollution from coal-fired power stations in 2019.[61] The costs are broken down in Table 4 below, where 'burden of disease' represents the loss of wellbeing of the individual through pain, suffering, morbidity or mortality in monetary terms.

As noted above in section 2.2, NSW records the greatest number of health impacts with approximately 450 babies being born with low birth-weight, 7,582 asthma symptoms in children and young adults and 477 premature deaths each year. Using these figures and the costing methodology adopted in the Johnson et al 2020 Report, the cost to the annual NSW economy is $1.4 billion.[62] This equates to an extraordinary 10-year health cost of $14 billion.

Table 4: Estimated health costs Australia-wide and for NSW associated with health impacts from coal-fired power stations

Negative Health Outcome	Estimated costs (2019 Australian dollars)					
	Economic		Burden of Disease		Total	
	AU	NSW	AU	NSW	AU	NSW
Extra Low Birthweight Live Births	$101m	$54m	$275m	$146m	$376m	$200m
Extra Person-Days of Asthma Symptoms	$1m	$0.5m	$10m	$5m	$11m	$5.5m
Extra Premature Deaths	$147m	$89m	$1,890m	$1,148m	$2,036m	$1,237m
Total	$249m	$143.5m	$2,174m	$1,299m	**$2,423m**	**$1439.2m**

In considering the health costs of specific pollutants, Broome et al concluded that the life-years produced by the complete removal of nitrogen oxides and sulfur oxide emissions from coal-fired power stations in the Greater Metropolitan Region to have a present value of $1.8 billion and $0.66 billion respectively and that these figures "…likely underestimate of the full health benefits of coal-fired power station emissions controls because exposure to NO_2 and SO_2 (components of NO_x and SO_x respectively) is associated with health effects that are independent of the health effects of $PM_{2.5}$."[63]

Broome et al highlights an important point: fundamentally, health-cost estimations are inherently conservative. This is because they typically only quantify the health impacts of specific pollutants from coal-fired power stations and fail to account for the health impacts from other pollutants that would also be reduced by the installation of BACT. For example, the Farrow et al 2020 Report only quantified the health impacts from nitrogen dioxide, sulfur dioxide and $PM_{2.5}$, it did not include other pollutants such as mercury.[64] Additionally, the Farrow et al 2020 Report relies on population spatial

[60] Chris Johnson et al, 'Costs of Negative Health Outcomes Arising from Air Pollution from Coal-fired Power stations', Actuaries Institute of Australia Annual Hackathon (Report, August 2020).
[61] Aidan Farrow, Andreas Anhäuser and Lauri Myllyvirta, above n 48.
[62] Environmental Justice Australia can provide the Committee with the complete Johnson et al report upon request. It contains the methodology and assumptions upon which these figures are based.
[63] R A Broome et al, above n 50, 6.
[64] Aidan Farrow, Andreas Anhäuser and Lauri Myllyvirta, above n 48, 15.

distribution data from 2010 and since Australia's population has grown by approximately 14% since 2010, the estimation of the total health impact may therefore be further underestimated.[65]

3.2 Cost of pollution control technology

Various forms of technology exist to reduce emissions from coal fired power stations, including:

- biomass cofiring, which reduces sulfur dioxides;
- combustion optimisation for nitrogen oxides;
- low nitrogen oxides burners, which, when coupled with low nitrogen oxides burners can reduce emissions by up to 50%;
- over-fire air using soot blower ports;
- wet scrubbers, or flue gas desulfurisation (**FGD**), which can remove up to 99% of sulfur pollution and also remove mercury; [66]
- selective catalytic reduction methods (**SCR**), which can reduce over 90% of nitrogen oxides from emissions;[67] and
- fabric bag filters, to reduce solid particles emissions.

Out of the above, only fabric filtration technology has been adopted in NSW coal-fired power stations.

Overall, the costs of installing FGD and SCR are falling globally.[68] Despite this, operators maintain that installing BACT is too costly. This argument has been raised by Delta in its 2015 and current application under the Clean Air Regulation for an exemption from the Group 5 nitrogen oxides emission limits.

In 2019, the Australian Energy Council, which represents the interests of coal-fired power station operators, commissioned WSP Global (**WSP**) to report on the considerations for retrofitting emissions control systems in Australian coal-fired power stations (**WSP Report**).[69] WSP developed performance estimates for four typical power stations and concluded that the capital and operating costs of retrofitting the coal-fired fleet in Australia were "not insignificant".[70] Table 5 outlines the BACT capital costs in the WSP Report.

Table 5: WSP estimates ($) of BACT capital costs[71]

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[65] Aidan Farrow, Andreas Anhäuser and Lauri Myllyvirta, above n 48, 15 citing Australian Bureau of Statistics (25 March 2020). 3218.0 Regional Population Growth, Australia, 2018-19. Retrieved from <https://www.abs.gov.au/AUSSTATS/abs@.nsf/mf/3218.0> on 2020-07-14.
[66] Leon Walker, Wet Scrubbing 'Most Versatile, Cost Effective Air Pollution Control (21 January 2014) Environmental Leader. <https://www.environmentalleader.com/2014/01/wet-scrubbing-most-versatilecost-effective-air-pollution-control/>.
[67] United States Environmental Protection Agency Clean Air Technology Center, 'Technical Bulletin: Nitrogen Oxides (NOx), Why and How They are Controlled' (1999) <https://www3.epa.gov/ttncatc1/dir1/fnoxdoc.pdf>.
[68] The Australia Institute, 'Coffin it up: Submission to NEPM air quality review regarding cost benefit analysis' (August 2019) 24-29 <http://www.environment.gov.au/submissions/nepc/aaqnepm2019/submission158-the-australia-institute.pdf>.
[69] WSP, Considerations for Retrofitting Emissions Control Systems in Australian Coal Power Plants (October 2019) <https://www.energycouncil.com.au/media/17633/wsp-final-report.pdf>.
[70] Ibid 7.
[71] Ibid 4.

Power station unit size	Fabric bag filter	FGD	SCR
350 MW Black coal	36,700,000	187,500,000	51,200,000
450 MW Black coal	42,400,000	212,500,000	58,600,000
720 MW Black coal	67,800,000	277,900,000	88,800,000
500 MW Brown coal	91,400,000	308,700,000	102,100,000

The estimated capital cost of retrofitting fabric bag filters on a 720MW black coal-fired power plant is estimated to be $67.8 million. This contrasts significantly to the total $55 million Delta actually spent to install fabric bag filters on its two 660MW units at Vales Point in 2007.[72] It therefore appears that the estimates in the WSP Report may overestimate the actual cost of this form of BACT and may indicate that other costings contained in the WSP Report a similarly inflated, and at the very least should be independently reviewed, preferably by engineers with specific experience in retrofitting coal-fired power stations

The Committee must consider these estimated costs in light of the estimated $2.4 billion in health costs from NSW coal-fired power stations projected over the next ten years.

The costs in the WSP Report must also be considered against the scale of the costs that major refurbishments involve.

For example, AGL recently commenced a $152 million upgrade to Bayswater, which will increase the capacity of Bayswater by 100MW. AGL asserts it will improve efficiencies and will not result in increased emissions.[73] This was on top of an already $70 million upgrade completed in 2019.[74] At Eraring, approximately $600 million was spent on upgrade works during 2010-2012, before it was acquired by Origin Energy.[75] Most recently, Origin Energy spent $92 million on an overhaul at Eraring.[76] Operators of coal-fired power stations are committing to upgrades and maintenance works as part of their continuing operations to ensure returns for investors, however when it comes to installation of BACT, which would ensure the health of the community and internalise the costs of their pollution, operators consider the cost economically unfeasible. This is an argument which is convenient to the power station operators, because it allows them to externalise the true cost of their operations and maximise profit at the expense of NSW. Further, they are doing this at a time

[72] Delta Electricity, 'Clean Air Summit – An industry perspective on best practice: Delta Electricity' (2017, Powerpoint Presentation) <https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/air/clean-air-2017-bryan-beudeker.pdf?la=en&hash=4FEDB8E677C827D7519AC69694F01A7A8099EEF7>.
[73] AGL 'Largest maintenance works underway at AGL Bayswater' (March 2021) <https://www.agl.com.au/about-agl/media-centre/asx-and-media-releases/2021/march/largest-maintenance-works-underway-at-agl-bayswater>.
[74] AGL 'AGL invests $70 million at Bayswater to improve reliability and safety' (January 2019) <https://www.agl.com.au/about-agl/media-centre/asx-and-media-releases/2019/january/agl-invests-70-million-at-bayswater-to-improve-reliability-and-safety>.
[75] Eraring Energy, Ten Years of Achievement & Growth (2010) 4 <https://media.opengov.nsw.gov.au/pairtree_root/af/6b/e0/1b/f8/3e/ca/26/37/2f/2e/65/bd/b9/0a/30/obj/document.pdf#:~:text=Eraring%20Power%20station%2C%20which%20makes,a%20%24600%20million%20upgrade%20project>.
[76] Origin Energy, 2020 Annual Report 'Good Energy' (2020) 23 <https://www.originenergy.com.au/content/dam/origin/about/investors-media/documents/origin_annual_report_fy2020.pdf>.

when loans obtained by coal-fired power stations for upgrades are currently subject to the lowest interest rates in Australian history.[77] We note that based on the projected closure dates of coal-fired power stations, the operators are likely to have sufficient time to pay off those loans and continue to operate at a profit.[78] The projected closure dates are currently as follows:[79]

- Liddell – LD04, 1 April 2022; LD01, 1 April 2023; LD02, 1 April 2023; LD03, 1 April 2023;
- Vales Point – VP5, 2029; VP6, 2029;
- Eraring – ER04, 2030; ER01, 2031; ER02, 2032; ER03, 2032;
- Bayswater – BW01, 2035; BW02, 2035; BW03, 2035; BW04, 2035.
- Mount Piper – MP1, 2042; MP2, 2042.

As part of this Inquiry, we recommend that the Committee seek to establish a clear timeline of operators' existing and projected major refurbishment dates and commitments to help inform when the installation of BACT at each coal-fired power station is achievable by.

Fundamentally, communities calling for the installation of BACT have encountered difficulties in critically examining industry-estimated costs of the installation of BACT.

This is due to the lack of publicly available information on each coal-fired power station's design and engineering statistics, which is required to produce accurate cost estimations. We recommend that as part of the Inquiry, the Committee seek further information from operators as to the estimated cost of installing BACT at each coal-fired power station based on the site-specific design and engineering characteristics of the particular coal-fired power station. Further this information should be independently reviewed by engineers who have experience in retrofitting coal-fired power stations.

3.3 Load based licencing scheme

The NSW Load Based Licensing Scheme is relevant to this Inquiry because it presents another avenue for ensuring that the costs to the community from air pollution generated by heavy industry are properly accounted for.

The 'polluter pays' principle dictates that those who generate pollution and waste should bear the cost of containment, avoidance or abatement.[80] The Load Based Licencing scheme requires polluters to pay licence fees based on the amount of the pollution produced. It was conceived to provide a financial incentive for polluters to reduce their emissions of pollution, adopt cleaner technologies and to determine the most cost effective way of doing so.[81]

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[77] Reserve Bank of Australia 'Cash Rate Target' (2021) <https://www.rba.gov.au/statistics/cash-rate/>.
[78] AGL 'Annual Report 2020' (2020) 9 and 155-165 <https://www.agl.com.au/-/media/aglmedia/documents/about-agl/asx-and-media-releases/2020/2097212_annualreport.pdf>.
[79] Australian Energy Market Operator, 'Generating unit expected closure year – May 2021' (10 May 2021) <https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information>.
[80] *Protection of the Environment Administration Act 1991* (NSW) s 6(2)d)(i).
[81] NSW Environment Protection Authority, *Review of the Load-Based Licensing Scheme* (Issues Paper, October 2016) 16–17.

Despite the intention of the scheme, the existing fees have not incentivised the installation of BACT at coal-fired power stations or resulted in any significant reduction of air pollution from NSW coal-fired power stations – the fees are set too low.

The Load Based Licencing scheme has been under review since late 2016. In redeveloping the Load-Based Licencing scheme, the NSW Government should ensure that fees are set at a level that incentivises pollution reduction and internalises the cost of the pollution.. Using data from the Australian Academy of Technological Science and Engineering, it has been estimated that licence fees would have to increase by a factor of almost 50 to properly internalise the health costs created by the NSW power stations.[82]

We recommend that as part of the Inquiry, the Committee consider all avenues for driving down air emissions from coal-fired power stations.

4. Amendments proposed in Clean Air Bill

4.1 Current NSW emissions standards compared to international jurisdictions

NSW's risk-based approach to air pollution regulation falls well short when compared with its international counterparts. As indicated in section 1.3, although the NSW regulatory framework requires advances in pollution reduction to be made, this is not occurring with the speed that is required to adequately protect human health and reduce the burden of health costs associated with air pollution from coal-fired power stations.

In other jurisdictions, older units have successfully complied with stricter emission limits as strong pollution reduction laws have come into force. The technology to meet contemporary emissions limits is mature. For several decades the United States (**US**), European Union (**EU**), South Korea, China, Japan amongst other jurisdictions have required increasingly effective controls for solid particles, nitrogen oxides, sulfur dioxide and mercury.

Initially, determinations of the BACT in the US were considered complex and difficult but as the BACT matured, the scientific and regulator consensus evolved and settled on the fundamental choices for best practice pollution controls in coal-fired power stations. [83] In 2011, the US EPA introduced the Mercury and Air Toxics Standards (**MATS**) to reduce mercury, heavy metal and acid gas emissions from coal-fired power stations. The MATS sets standards for all hazardous air pollutants based on BACT.[84]

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[82] Doctors for the Environment Australia, Submission to NSW Environment Protection Agency, *Review of the Load-Based Licensing Scheme* (December 2016) 6; Tom Biegler, Australian Academy of Technological Sciences and Engineering, *The Hidden Costs of Electricity: Externalities of Power Generation in Australia* (Report, March 2009; Ben Ewald, 'The Value of Health Damage Due to Sulphur Dioxide Emissions from Coal-Fired Electricity Generation in NSW and Implications for Pollution Licences' (2018) 42(3) *Australian and New Zealand Journal of Public Health* 227.

[83] United States Environment Protection Authority, 'Cleaner Power Plants' (October 2020) <https://www.epa.gov/mats/cleaner-power-plants#limits>.

[84] United States, Federal Register 77(32), 16 February 2012, 'National Emissions Standards for Hazardous Pollutants From Coal and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units' <https://www.govinfo.gov/content/pkg/FR-2012-02-16/pdf/2012-806.pdf>.

In the EU, BACT conclusions were developed under Directive 2010/75/EU for large combustion plants, which are used as a reference for setting individual permit conditions for each coal-fired power station.[85] In determining BACT, the EU undertook lengthy and comprehensive reviews of the performance expected from installation of BACT which included extensive multi-year consultation with interested parties. Directive 2010/75/EU adopts limits aimed at achieving a high level of protection of human health and the environment.[86]

In *The People's Clean Air Action Plan for NSW* we summarise the representative emission limits for existing coal-fired power stations in other jurisdictions based on each jurisdiction's regulatory framework.[87] Table 6 outlines these limits and compares them to the emission limits of NSW coal-fired power stations (as summarised above in section 1.1, Table 3). Notably, NSW coal-fired power stations have nitrogen oxides limits that are 7-10 times higher than those in the EU and more than double the allowable limits in the US. Compared to EU limits, NSW sulfur dioxide limits are over thirteen times higher, solid particles are six times higher and mercury are 12 times higher.

Table 6: Emission limits in international jurisdictions compared to NSW

	SO_2 (mg/m^3)	NO_x (mg/m^3)	PM (mg/m^3)	Hg (ug/m^3)
China[88]	35	50	10	30
Japan[89]	68.3	57.5	14.3	10
South Korea[90]	142.5	102.5	10	50
EU[91]	130	150	8	2.0/4.0
US[92]	640	640	23	1.7/15.3
NSW	1700/1900	1100/1500	50	50

[85] Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants (notified under document C(2017) 5225).
[86] European Commission, 'Industrial Emissions Directive' <https://ec.europa.eu/environment/industry/stationary/ied/legislation.htm>.
[87] Environmental Justice Australia, above n 1, 13 Table 3.
[88] 火电厂大气污染物排放标准/'Emission Standard of Air Pollutants for Thermal Power Plants' (China) AQSIQ, GB 13223-2011, 29 September 2011, partial English translation: https://english.mee.gov.cn/Resources/standards/Air_Environment/Emission_standard1/201201/W020110923 324406748154.pdf, full English translation available <https://www.codeofchina.com/search/default.html?page=1&keyword=GB13223-2011>, see also <http://www.mep.gov.cn/gkml/hbb/bwj/201512/W020151215366215476108.pdf>.
[89] This is a compilation of actual emissions values, 90th percentile shown. See Shannon N. Koplitz et al 'Burden of Disease from Rising Coal-fired Power Plant Emissions in Southeast Asia' (2017) 51(3) *Environmental Science & Technology* 1467 <http://pubs.acs.org/doi/abs/10.1021/acs.est.6b03731>.
[90] Air Environment Conservation Act Enforcement Regulations <http://www.law.go.kr/%EB%B2%95%EB%A0%B9/%EB%8C%80%EA%B8%B0%ED%99%98%EA%B2%BD%EB%B3 %B4%EC%A0%84%EB%B2%95%20%EC%8B%9C%ED%96%89%EA%B7%9C%EC%B9%99>.
[91] Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants (notified under document C(2017) 5225).
[92] United States, Federal Register 77(32), 16 February 2012, 'National Emissions Standards for Hazardous Pollutants From Coal and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units' <https://www.govinfo.gov/content/pkg/FR-2012-02-16/pdf/2012-806.pdf>.

In some respects, it could be suggested that Australia is fortunate because the rest of the world has done the work to develop best practice pollution control standards for existing power stations. NSW must follow suit, particularly if it is committed to the EPA becoming a world class regulator.[93]

4.2 Standards proposed by Clean Air Bill

The fastest way to bring down ambient air pollution levels is to strictly regulate pollution at its source. The Clean Air Bill recognises this. The standards proposed in s 128(1AA) Clean Air Bill are a significant improvement on the current standards in the Clean Air Regulation for nitrogen oxides and solid particles. The introduction of legislated standards for sulfur dioxide and mercury are also substantially lower than current emission limits set in individual environment protection licences.

If the Clean Air Bill is enacted, coal-fired power stations would have to install BACT to meet the proposed standards, resulting in improved health outcomes for communities and a reduction of the estimated $ 1.4 billion annual health bill for NSW.

We do note however, that the proposed Clean Air Bill standards are still higher than those that can be achieved with the installation of BACT by existing NSW coal-fired power stations. Based on what has been achieved in the EU for existing coal-fired power stations, the following emissions levels should be able to be achieved by NSW coal-fired power stations with installation of BACT.[94]

Table 7: Emissions levels that can be achieved with installation of BACT for existing NSW coal-fired power stations

	Annual Average (mg/m^3)	Short term (daily or reference test) (mg/m^3)
Solid particles[95]	2-8	3-11
Sulfur dioxide[96]	10-130	25-165
Nitrogen oxides[97]	65-150	<85-165
Mercury[98]	<1-4 (ug/m^3)	<1-4 (ug/m^3)

[93] NSW Environment Protection Authority 'Draft Regulatory Strategy' (2021) 6 <https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.nswepa-yoursay.files/8216/1172/6187/0595_Regulatory_Strategy-LANDSCAPE-v011.pdf>.
[94] Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants (notified under document C(2017) 5225).
[95] Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants (notified under document C(2017) 5225), Table 6 L 212/34.
[96] Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants (notified under document C(2017) 5225), Table 4, L 212/32.
[97] Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants (notified under document C(2017) 5225), Table 3, L 212/30.
[98] Commission Implementing Decision (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants (notified under document C(2017) 5225), Table 7, L212/35.

We therefore recommend that the proposed Clean Air Bill standards be amended to reflect those standards in Table 7 to ensure that standards set by legislation best reflect what is achievable by the installation of BACT.

4.3 Proposed commencement of Clean Air Bill

We note that if enacted, the Clean Air Bill "would commence on the date of assent". Whilst we support the swift introduction of tougher emissions standards to protect human health, we acknowledge that the installation of BACT in existing coal-fired power stations requires planning, both for power stations to prepare, contract, construct and test controls and where possible to align connection of air controls during schedule outages to minimise outages and to ensure consistent electricity supply. This will require cooperation and scheduling between the operators and the Australian Energy Market Operator.

For example, when the US implemented the MATS, existing coal-fired power plants were given time to meet the new standards. All sources of pollution had to meet the MATS standards within three years, with an additional year permitted by state authorities on a case-by-case basis.[99]

In *The People's Clean Air Action Plan for NSW* we recommend different approaches to enabling the orderly installation of pollution controls in NSW coal-fired power stations. Three possible approaches are as follows: [100]

1. installation of pollution controls is staggered to coincide with scheduled outages in the National Electricity Market;
2. each operator is required to control a set percentage of its generating capacity each year, commencing three years after the date of the regulatory or legislative changes to emission limits;
3. retrofit dates are set for specific plants.

We therefore recommend that the Clean Air Bill be amended to specify that it commence on an appropriate later date. Based on the US example and assuming the Clean Air Bill returns to the House in 2021, nominally this should be on a date in 2024.[101]

Environmental Justice Australia
29 June 2021

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[99] United States Environment Protection Authority, 'Cleaner Power Plants' (October 2020) <https://www.epa.gov/mats/cleaner-power-plants#limits>.
[100] Environmental Justice Australia, above n 1, 16.
[101] *Interpretation Act 1987* (NSW) s 23(1)(b).

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The People's Clean Air Action Plan for NSW

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Further information

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Contents

1. Introduction

There is no safe level of exposure to air pollution. Australia experiences levels of air pollution that significantly impact the health of our communities. Collective studies estimate that between 2,616 and 4,884 people die prematurely from exposure to air pollution every year in Australia.[1] The economic cost of premature death attributed to ambient air pollution in Australia has been estimated at up to AUD$24 billion per year.[2] Low levels of exposure to air pollution can cause adverse health impacts,[3] however the lower the pollution, the lower the health impacts. Driving pollution down to as close to zero as possible would have significant benefits.

This Clean Air Action Plan identifies the largest sources of controllable air pollution, and the actions that the NSW government must take to reduce it to best practice control standards. It has been developed in collaboration between health experts, environmental lawyers, community groups in areas impacted by air pollution, and international experts. We urge the NSW government to adopt this plan and the actions it lists throughout.

The overwhelming industrial source of air pollution in Australia and NSW is coal-fired power stations.[4] The other major sources that contribute to health impacts are coal mining, motor vehicles and smoke from wood heaters.[5] The most recent analysis of health impacts caused by coal-fired power stations in Australia has found that they contribute to 845 babies being born with low birth-weight, 14,434 children with asthma, and 785 premature deaths each year.[6] The health cost to the Australian

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[1] Hanigan, I.C.; Broome, R.A.; Chaston, T.B.; Cope, M.; Dennekamp, M.; Heyworth, J.S.; Heathcote, K.; Horsley, J.A.; Jalaludin, B.; Jegasothy, E.; et al. Avoidable Mortality Attributable to Anthropogenic Fine Particulate Matter (PM2.5) in Australia. *Int. J. Environ. Res. Public Health* 2021, 18, 254: https://doi.org/10.3390/ijerph18010254; Australian Institute of Health and Welfare (AIHW) (2016). Australian burden of disease study: impact and causes of illness and death in Australia 2011, AIHW, Canberra; Begg, S. (2007). The burden of disease and injury in Australia 2003, PHE 82, AIHW, Canberra; Institute for Health Metrics and Evaluation (IHME). Global Burden of Disease Study 2017. Seattle, WA: IHME, University of Washington, 2017. Accessed 10/06/2018: http://vizhub.healthdata.org/gbd-compare.

[2] See: Australian Institute of Health and Welfare (AIHW) (2016). Australian burden of disease study: impact and causes of illness and death in Australia 2011, AIHW, Canberra; Begg, S. (2007). The burden of disease and injury in Australia 2003, PHE 82, AIHW, Canberra; Access Economics (2008). The health of nations: the value of a statistical life, Australian Safety and Compensation Council, Australian Government Department of Education, Employment and Workplace Relations, Canberra.

[3] World Health Organization. Regional Office for Europe. (2006). Air quality guidelines global update 2005: particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Copenhagen: WHO Regional Office for Europe. https://apps.who.int/iris/handle/10665/107823

[4] See: http://www.npi.gov.au/npidata/action/load/emission-by-substance-result/criteria/destination/ALL/source-type/ALL/subthreshold-data/Yes/substance-name/All/state/NSW/year/2019; https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/air/19p1917-air-emissions-inventory-2013.pdf?la=en&hash=9217ADF2C8D5647147FF00F447258319D00BB75D/.

[5] See: http://www.npi.gov.au/npidata/action/load/emission-by-substance-result/criteria/destination/ALL/source-type/ALL/subthreshold-data/Yes/substance-name/All/state/NSW/year/2019; https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/air/19p1917-air-emissions-inventory-2013.pdf?la=en&hash=9217ADF2C8D5647147FF00F447258319D00BB75D/.

[6] Dr. Aidan Farrow, Andreas Anhäuser and Lauri Myllyvirta, *Lethal Power: How Burning Coal is Killing People In Australia* (August 2020), pp 22-24. Available at: https://www.greenpeace.org.au/wp/wpcontent/uploads/2020/08/GPAP-Lethal-Power-full-report.pdf.

economy from coal-fired power stations alone is $2.4 billion dollars annually.[7] Air pollution from coal-fired power stations disproportionately impacts communities living near coal-fired power stations, making this one of the most significant environmental justice issues in Australia. Air pollution reduction measures cannot only be undertaken primarily in larger population areas, such as metropolitan Sydney.

In 2005, the annual health cost of air pollution in the Sydney Greater Metropolitan Region (GMR) was estimated to be $893 per head of population or $4.7 billion,[8] equivalent to $6.4 billion a year in 2015 terms.[9] The 2014 Impact Statement to the Draft Variation to the *National Environment Protection (Ambient Air Quality) Measure* noted that the savings in associated health costs of reducing ambient particulate matter concentrations in the NSW Greater Metropolitan region (GMR) was estimated to be $5.7 billion per annum.[10]

The NSW government initiated the development of a Clean Air Strategy several years ago. The NSW population is exposed to significant amounts of air pollution each year. As the most populous state, reducing air pollution and lifting the health burden should be treated as a priority. Fortunately, the rest of the world has undertaken air pollution reduction measures that NSW can learn from and implement to protect public health.

The devastating bushfires of the 2019-2020 summer period and the ongoing COVID-19 global pandemic have highlighted air pollution as a significant public health problem. Research published in the Medical Journal of Australia estimates that more than 400 people died from exposure to air pollution during the fires,[11] with many more likely to have developed chronic illness, or experienced serious short-term health impacts.[12] The total estimated health costs of the bushfire smoke is $1.95 billion.[13] It is a matter of when, not if, Australia will experience severe bushfires again. Without reducing existing sources of air pollution to best practice control standards, the public health consequences of air pollution from subsequent bushfires will continue to be exacerbated, especially for those communities who are already exposed to high levels of air pollution throughout the year.

[7] Johnson, Chris et al, 'Costs of Negative Health Outcomes Arising from Air Pollution from Coal-fired Power stations', Actuaries Institute of Australia Annual Hackathon, 19 August 2020.

[8] NSW Department of Environment and Conservation (DEC) 2005, *Air Pollution Economics: Health Costs of Air Pollution in the Greater Sydney Metropolitan Region*, Department of Environment and Conservation, Sydney: www.epa.nsw.gov.au/your-environment/air/air-nsw-overview/costs-benefits-air-pollution-controls

[9] NSW Environment Protection Authority (EPA) and Office of Environment & Heritage (OEH) 2016, *Consultation Paper Clean Air for NSW*, Environment Protection Authority and Office of Environment & Heritage, Sydney: www.epa.nsw.gov.au/your-environment/air/clean-air-nsw

[10] National Environment Protection Council (NEPC) 2014, *Draft Variation to the National Environment Protection (Ambient Air Quality) Measure: Impact Statement*, National Environment Protection Council, Canberra: www.environment.gov.au/protection/nepc/nepms/ambient-air-quality/variation-2014/impact-statement

[11] Nicolas Borchers Arriagada, Andrew Palmer, David Bowman, Geoffrey Morgan, Bin Jalaludin, Fay Johnston, Unprecedented smoke-related health burden associated with the 2019-20 bushfires in eastern Australia, *Medical Journal of Australia*, 12 March 2020. Available at: https://onlinelibrary.wiley.com/doi/pdf/10.5694/mja2.50545.

[12] Australian Medical Association, "AMA warns of new health threats from ongoing bushfire crisis", January 3 2020: https://ama.com.au/media/new-health-threats-escalating-bushfire-crisis

[13] Johnston, F.H., Borchers-Arriagada, N., Morgan, G.G. *et al.* Unprecedented health costs of smoke-related $PM_{2.5}$ from the 2019–20 Australian megafires. *Nature Sustainability* (2020). https://doi.org/10.1038/s41893-020-00610-5

Air pollution can cause health problems like heart attacks, strokes, diabetes and high blood pressure, which have been identified as pre-existing medical conditions that raise the chances of death from COVID-19 infection.[14] By implementing this Clean Air Action Plan, pre-existing sources of air pollution will be reduced which may assist in reducing health impacts from both these crises.

2. Air pollution

2.1 Pollutants and pollution sources

Industrial processes emit a broad range of pollutants that can impact health. It is generally accepted that there are five key pollutants released or formed in the atmosphere from numerous and diverse stationary and mobile sources that cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare. These pollutants are fine particle pollution ($PM_{2.5}$), coarse particle pollution (PM_{10}), oxides of nitrogen (NO_x), sulfur dioxide (SO_2), and ozone (O_3). These pollutants also represent the majority of air pollutants for which standards are set in the *National Environment Protection (Ambient Air Quality) Measure*.[15] The health impacts of these pollutants are outlined below in section 2.5.

Particle pollution consists of tiny solid particles that come in a range of sizes, measured in micrometres. Coarse particle pollution is usually referred to as PM_{10} (that is, particle size of 10 micrometres in diameter), which generally forms as dust (such as coal dust) and is inhalable into the lungs. Fine particle pollution, known as $PM_{2.5}$, is much smaller, at 2.5 micrometres in diameter. Its small size means it can get deeper into the lungs and into the bloodstream, causing a deadly range of health impacts (see section 2.5 below).

NO_x and SO_2 are gases that are formed during the process of combustion. In addition to being toxic of their own accord, both SO_2 and NO_x form secondary fine particle pollution,[16] creating additional huge quantities of deadly fine particle pollution. In addition to improving reduction of fine particle emissions from industrial sources, strict control measures to drive down SO_2 and NO_x emissions must be installed to reduce the creation of secondary fine particle pollution. Nitrogen dioxide (NO_2) is the main oxide of nitrogen pollutant of concern.

Normally, ozone is not directly emitted by a source; it is formed at ground level when NO_x reacts with other chemicals in the air, including volatile organic compounds. (See more on ozone in section 7 below).

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[14] See: https://www.hsph.harvard.edu/c-change/subtopics/coronavirus-and-pollution/. See also: Cole, M., et al., *Air Pollution Exposure and COVID-19* (2020) available at: http://ftp.iza.org/dp13367.pdf; Liang, D., et al. *Urban Air Pollution May Enhance COVID-19 Case-Fatality and Mortality Rates in the United States* (2020) available at: https:// doi.org/10.1101/2020.05.04.20090746; Tian, H., et al. (2020). *Risk of COVID-19 is associated with long-term exposure to air pollution* (2020) available at: https://doi.org/10.1101/2020.04.21.20073700.

[15] Carbon monoxide (CO) and lead (Pb) have also been listed as criteria pollutants. Improvements in mobile source fuels and technologies have significantly reduced the risk posed by these pollutants.

[16] Ewald, Ben., *The Health burden of fine particle pollution from electricity generation in NSW* (November 2018) p. 20. Available at: https://www.envirojustice.org.au/wp-content/uploads/2018/11/Ewald_B_2018_The_health_burden_of_fine_particle_pollution_from_electricity_generation_in_NSW.pdf.

Mercury (Hg) is well-known for its toxicity and, while not emitted by a broad range of sources, is nonetheless a pollutant of concern. Although mercury is released in much lower levels than PM, SO_2, NO_x and ozone, it is highly toxic and accumulates in both the environment and the body. Any release of mercury is significant. Specific highly toxic substances such as volatile organic compounds (VOC) are also a concern, both on their own and in the formation of ozone.

2.2 Monitoring and access to information

Air quality monitoring must be improved to effectively measure the health risk for at-risk communities. There is very little air pollution monitoring undertaken at roadsides in Sydney, where traffic is heavy and causes poor air quality in front of schools, kindergartens, residential facilities, aged-care facilities and hospitals. The City of Sydney Council, for example, has stated that the lack of monitoring in the inner-city areas of Sydney prevents the Council from taking measures to reduce air pollution.[17]

In addition to monitoring, access to information about air pollution is critical. Under their pollution licences, power stations in NSW are required to upload monitoring information on a monthly basis onto their websites. Access to information could be improved by aggregating this data onto a single EPA website, as is the case with real-time air pollution information from NSW government monitors.

Action: By September 2021, develop an air quality monitoring plan that increases the level of, and access to, air quality monitoring and information, including by:

- Installing and/or increasing permanent air quality monitoring stations in every community that is near a major industrial source of pollution, such as coal-fired power stations, with new monitors at Lake Macquarie and Lithgow.
- Implementing localised monitoring networks in areas with large traffic flow and with high wood-burning heater usage, including the use of low-cost monitors.
- Ensure access to monitoring data be made available in real-time, on a single website maintained by the EPA.
- Funding and implementing an *AirSmart* health promotion campaign to minimise the health impacts of poor air quality.[18]

2.3 Main sources of air pollution in NSW

NSW maintains an Air Pollutant Inventory for the greater metropolitan region (GMR), which includes Sydney, Newcastle and Wollongong regions. The NSW Air Pollutant Inventory is updated every seven

[17] Jess Miller, NSW Health risks bushfire and drought inquiry: https://www.parliament.nsw.gov.au/lcdocs/submissions/67634/0049%20Ms%20Jess%20Miller,%20Councillor,%20City%20of%20Sydney%20Council.pdf
[18] See: Asthma Australia, 'Now is the time to get AirSmart Australia', 1 September 2020: https://asthma.org.au/about-us/media/now-is-the-time-to-get-airsmart-australia/

years.[19] Although the Air Emissions Inventory is useful, it does not include dangerous pollutants such as mercury. To fill in the gaps for mercury, data from the NPI is used.

According to the most recent Air Emissions Inventory, generation of electrical power from coal is the highest source of NOx and SO_2 in the GMR, by significant amounts compared with the next highest sources. While coal-fired power stations are not the biggest source of direct $PM_{2.5}$ pollution, since both SO_2 and NO_x form secondary $PM_{2.5}$ pollution, coal-fired power stations are still a big source of $PM_{2.5}$ in the GMR. For example, power station SO_2 produces close to 20 percent of $PM_{2.5}$ at Richmond in Sydney's north-west on an annual basis.[20] Overall, the coal industry in NSW, whether burning coal to generate electricity or coal mining, is the largest industrial contributor to NSW's air pollution. This largely correlates with industry self-reporting in the most recent NPI data.

Table 1: Top three sources of key pollutants in NSW from the NSW Air Pollutant Inventory

PM_{10}	$PM_{2.5}$	NO_x	SO_2	Mercury
Bushfires and prescribed burning – 88,012,000kg (43%)	Bushfires and prescribed burning – 74,688,000kg (70.3%)	Coal-fired power stations – 139,000,000kg (45.7%)	Coal-fired power stations – 18,191,000 kg (84.9%)	Basic ferrous metal manufacturing – 230kg
Mining for coal – 68,020,000kg (33.2%)	Mining for coal – 10,238,000kg (9.64%)	Industrial vehicles and equipment – 30,767,000kg (10.1%)	Ships – 10,536,000 kg (4.52%)	Coal-fired power stations – 220kg
Marine Aerosol – 14,852,000kg (7.25%)	Solid Fuel Burning (Domestic) – 6,773,000kg (6.38%)	Bushfires and prescribed burning – 25,812,000kg (8.47%)	Aluminium production – 8,168,000 kg (3.5%)	Motor vehicles – 52kg

Source: NSW Air Emissions Inventory 2013

2.4 Where does the pollution go?

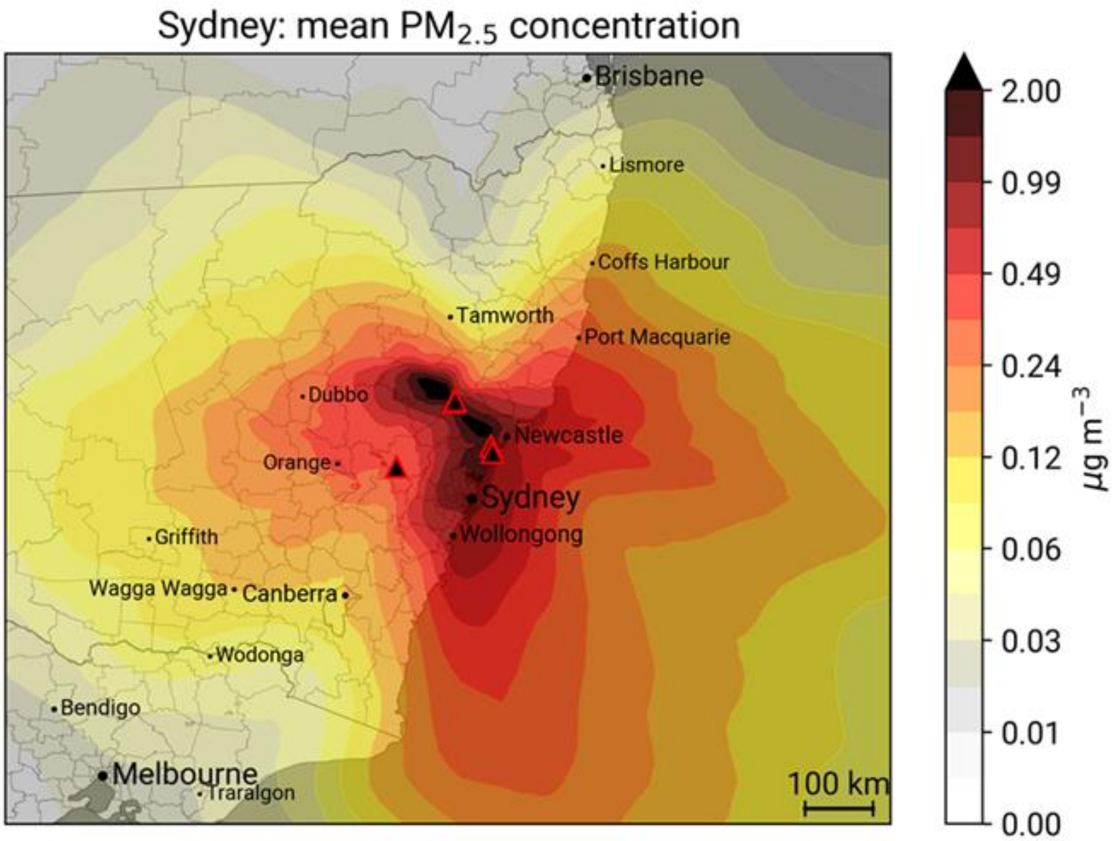
In the most recent assessment of air pollution from coal-fired power stations *Lethal Power: How Burning Coal is Killing People in Australia*,[21] international air quality modelling experts conducted industry-standard air modelling. This modelling showed that air pollution from coal-fired power stations travels far beyond a power station's location. Communities near the power station may be

[19] The last inventory was completed for 2013, and published in 2019. See: NSW Environment Protection Authority (2019) Air Emissions Inventory for the Greater Metropolitan Region in New South Wales: 2013 Calendar Year Consolidated Natural and Human-Made Emissions, October 2019: https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/air/19p1917-air-emissions-inventory-2013.pdf
[20] State of New South Wales Department of Planning, Industry and Environment (2019). NSW Electricity Strategy. November 2019: https://energy.nsw.gov.au/media/1921/download
[21] Dr. Aidan Farrow, Andreas Anhäuser and Lauri Myllyvirta, Lethal Power: How Burning Coal is Killing People In Australia (August 2020), available at: https://www.greenpeace.org.au/wp/wp-content/uploads/2020/08/GPAP-Lethal-Power-full-report.pdf.

exposed to the highest concentrations of air pollution under certain weather conditions,[22] but transport of $PM_{2.5}$ can extend for hundreds of kilometres and affect large populations in cities.[23]

Lethal Power shows that, depending on wind direction and speed, $PM_{2.5}$ pollution from coal-fired power stations in NSW travels across an enormous geographical area, contributing to poor air quality in Sydney, northwards towards Lismore and into South-East Queensland, and as far down as Shepparton in Victoria.[24] The highest concentrations of NO_2 air pollution from coal-fired power stations is in the airshed where the power stations is located. Not only does the pollution travel far, it is most concentrated at the source, disproportionally exposing people in nearby communities.

Figure 1: Annual mean near-surface PM2.5 concentration increases due to emissions from coal-fired power stations in NSW



Source: *Lethal Power: How Burning Coal is Killing People in Australia*

[22]Dr. Aidan Farrow, Andreas Anhäuser and Lauri Myllyvirta, Lethal Power: How Burning Coal is Killing People In Australia (August 2020), p. 5., available at: https://www.greenpeace.org.au/wp/wp-content/uploads/2020/08/GPAP-Lethal-Power-full-report.pdf.

[23] Dr. Aidan Farrow, Andreas Anhäuser and Lauri Myllyvirta, Lethal Power: How Burning Coal is Killing People In Australia (August 2020), p. 5., available at: https://www.greenpeace.org.au/wp/wp-content/uploads/2020/08/GPAP-Lethal-Power-full-report.pdf.

[24] Dr. Aidan Farrow, Andreas Anhäuser and Lauri Myllyvirta, Lethal Power: How Burning Coal is Killing People In Australia (August 2020), pp. 18-19., available at: https://www.greenpeace.org.au/wp/wp-content/uploads/2020/08/GPAP-Lethal-Power-full-report.pdf.

Air pollution from vehicles and wood heaters is largely localised. The heavier the traffic, the more air pollution is emitted. The most heavily impacted communities are often close to major ports, impacted by shipping and diesel-fuelled heavy vehicle movements. Smoke from wood heaters can sit in places such as Armidale for days in still weather, contributing to very poor air quality.[25] In NSW there is a paucity of ground-level air quality monitoring in urban areas with heavy traffic, and in areas where wood-burning heaters are predominantly used. The pervasive and widespread nature of pollution from coal-fired power stations means that even if localised sources of pollution like wood-burning and diesel trucks are reduced to zero, background concentrations of pollution will still pervade.

2.5 Health impacts of air pollution at existing concentrations

The International Agency for Research on Cancer classifies air pollution as a human carcinogen.[26] A 2019 global review of evidence found that air pollution can damage every organ and every cell in the human body.[27] In 2018, the director general of the World Health Organisation (WHO) declared air pollution a "public health emergency".[28] Children and older people are most vulnerable to the health impacts of air pollution.

The most dangerous form of air pollution is $PM_{2.5}$. There is abundant evidence that $PM_{2.5}$ exposure can cause adverse health effects and increased risk of death. [29] There is no lower threshold for these effects.[30] The science does not support that there is a safe level of exposure, so air quality standards are a reference level, not a safe level.[31] Long term exposure is particularly damaging, even at lower

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[25] State of NSW and Office of Environment and Heritage. (2019) *NSW Annual Air Quality Statement 2018*, p.14, 20. Available at: https://www.environment.nsw.gov.au/research-and-publications/publications-search/nsw-annual-air-quality-statement-2018

[26] World Health Organization (WHO) 2013, *Media Release No. 221, IARC: Outdoor air pollution a leading environmental cause of cancer deaths,* International Agency for Research on Cancer, World Health Organization, Lyon, France: www.iarc.fr/wp-content/uploads/2018/07/pr221_E.pdf

[27] Dean E. Schraufnagel, et al., Air Pollution and Noncommunicable Diseases: A Review by the Forum of International Respiratory Societies' Environmental Committee, Part 1: The Damaging Effects of Air Pollution, February 2019, Volume 155, Issue 2, Pages 409–416, Available at: https://doi.org/10.1016/j.chest.2018.10.042; Dean E. Schraufnagel, et al., (2019) Air Pollution and Noncommunicable Diseases: A Review by the Forum of International Respiratory Societies' Environmental Committee, Part 2: Air Pollution and Organ Systems, *CHEST Journal,* February 2019, Volume 155, Issue 2, Pages 417–426. Available at: https://doi.org/10.1016/j.chest.2018.10.041

[28] Dr Tedros Adhanom Ghebreyesus, "Air pollution is the new tobacco. Time to tackle this epidemic" *The Guardian*, October 27 2018. Available at: https://www.theguardian.com/commentisfree/2018/oct/27/air-pollution-is-the-new-tobacco-time-to-tackle-this-epidemic

[29] Dockery, Douglas W., et al., (1993) An Association between Air Pollution and Mortality in Six U.S. Cities, *New England Journal of Medicine*, 329(24): 1753-1759. https://www.nejm.org/doi/full/10.1056/NEJM199312093292401; Krewski D., et al., (2005) Reanalysis of the Harvard Six Cities Study, part I: validation and replication. *Inhalation Toxicology* 2005 Jun-Jul;17(7-8):335-42. Available at: https://doi.org/10.1080/08958370590929402U.

[30] Dockery, Douglas W., et al., (1993) An Association between Air Pollution and Mortality in Six U.S. Cities, *New England Journal of Medicine*, 329(24): 1753-1759. Available at: https://www.nejm.org/doi/full/10.1056/NEJM199312093292401; Krewski D., et al., (2005) Reanalysis of the Harvard Six Cities Study, part I: validation and replication. *Inhalation Toxicology* 2005 Jun-Jul;17(7-8):335-42. Available at: https://doi.org/10.1080/08958370590929402U.

[31] World Health Organization. Regional Office for Europe. (2006). Air quality guidelines global update 2005: particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Copenhagen: WHO Regional Office for Europe. Available at: https://apps.who.int/iris/handle/10665/107823.

levels of pollution. A recent study from Queensland found that long-term exposure to $PM_{2.5}$ was associated with increased all-cause mortality of two percent for each 1 µg/m^3 increase in annual $PM_{2.5}$, even where $PM_{2.5}$ levels were measured well-below air quality standards.[32]

Research led by the University of Sydney has found up to a four percent increased risk of out-of-hospital cardiac arrest (OHCA) associated with every 10 µg/m^3 increase in $PM_{2.5}$.[33] OHCA is a major medical emergency, with less than one in 10 people worldwide surviving these events.[34] Similarly, in Tasmania, where air pollution is mainly associated with wood heaters, a 10 µg/m^3 increase in daily $PM_{2.5}$ was associated with a 29 percent increase in hospital admissions for heart failure on the following day.[35]

In 2019, the Harvard Chan School of Public Health published an analysis of more than 95 million Medicare hospital insurance claims for adults aged 65 or older in the United States from 2000 to 2012.[36] The researchers found that each 1 µg/m^3 increase in $PM_{2.5}$ was associated with 2,050 extra hospital admissions, 12,216 days in hospital, and USD$31m in healthcare costs for diseases not previously associated with $PM_{2.5}$ including sepsis, kidney failure, and urinary tract and skin infections. These associations remained even at daily $PM_{2.5}$ concentrations below the WHO guideline. As such, the researchers concluded that substantial health and economic costs were linked to small $PM_{2.5}$ short-term increases.

Children are particularly vulnerable to $PM_{2.5}$ exposure due to the adverse effects on lung development. Australia's most common cause of general practitioner presentation in children under five is asthma and allergy. A 2015 Australian meta-analysis discovered that for every 2 µg/m^3 incremental increase in chronic exposure to traffic-related particulate matter, the risk of developing subsequent asthma in childhood increased by 14 percent.[37] Reduced lung health and impaired development in children holds lifelong consequences, including an increased risk of cardiovascular disease and associated mortality as an adult.[38]

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[32] Yu W, Guo Y, Shi L, Li S (2020) The association between long-term exposure to low-level $PM_{2.5}$ and mortality in the state of Queensland, Australia: A modelling study with the difference-in-differences approach. PLoS Med 17(6): e1003141. https://doi.org/10.1371/journal.pmed.1003141

[33] Bing Zhao, et al.,. (2020) Short-term exposure to ambient fine particulate matter and out-of-hospital cardiac arrest: a nationwide case-crossover study in Japan. *The Lancet Planetary Health*, 4(1): 15-23. Available at: https://doi.org/10.1016/S2542-5196(19)30262-1

[34] University of Sydney. "Air pollution impacts can be heart-stopping: Biggest study of dangerously small particulate matter and cardiac arrest." *ScienceDaily*, 28 January 2020. Available at: https://www.sciencedaily.com/releases/2020/01/200128115421.htm

[35] Huynh QL, Blizzard CL, Marwick TH*, et al* Association of ambient particulate matter with heart failure incidence and all-cause readmissions in Tasmania: an observational study *BMJ Open* 2018;8:e021798: http://dx.doi.org/10.1136/bmjopen-2018-021798

[36] Wei Yaguang, et al. (2019) Short term exposure to fine particulate matter and hospital admission risks and costs in the Medicare population: time stratified, case crossover study *BMJ* 2019; 367:l6258. Available at: https://doi.org/10.1136/bmj.l6258

[37] Bowatte G, Lodge C, Lowe A, Erbas B, Perret J, Abramson M, et al. The influence of childhood traffic-related air pollution exposure on asthma, allergy and sensitization: A systematic review and a meta-analysis of birth cohort studies. *Allergy*. 2015; 70(3):245-56.

[38] Ryan G, Knuiman MW, Divitini ML, James A, Musk AW, Bartholomew HC. Decline in lung function and mortality: The Busselton Health Study. *Journal of Epidemiology and Community Health*. 1999;53(4):230-4; Georgiopoulou VV, Kalogeropoulos AP, Psaty BM, Rodondi N, Bauer DC, Butler AB, et al. Lung function

$PM_{2.5}$ is not the only pollutant that adversely impacts health. At low concentrations, NO_2, SO_2 and O_3 can cause significant health problems. A number of Australian studies published in the last decade demonstrate statistically significant health impacts at pollutant concentrations well-below national standards for these pollutants.[39] Nitrogen dioxide is strongly associated with childhood asthma and impaired lung development, which can lead to lifelong adverse health effects and premature death.[40] Adverse neonatal outcomes, including preterm birth, low weight at birth and foetal growth restriction are associated with maternal exposures to NO_2, SO_2 and O_3.[41] Laboratory confirmed paediatric influenza has also been associated with ozone.[42] Middle-aged Australians exposed to nitrogen dioxide can experience exacerbations of current asthma, the incidence of new asthma, and atopy.[43] Long term exposure to SO_2, even at low concentrations, has been associated with cardiorespiratory mortality.[44]

Developing but as-yet-unconfirmed evidence suggests a large effect from traffic-related air pollution damaging children's brain growth.[45] If confirmed, this would be the largest and most economically harmful health impact of current air pollution exposure.

3. Controlling pollution from coal-fired power stations

Coal-fired power stations are the most significant controllable source of air pollution in NSW, which can be greatly reduced with best practice control standards.

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and risk for heart failure among older adults: the Health ABC Study. *American Journal of Medicine*. 2011;124(4):334-41; Sin DD, Wu L, Man SF. The relationship between reduced lung function and cardiovascular mortality: A population-based study and a systematic review of the literature. *Chest*. 2005;127(6):1952-9.

[39] See Clare Walter, Maxwell Smith et al. (2019) Health-based standards for Australian regulated thresholds of nitrogen dioxide, sulfur dioxide and ozone: Expert Position Statement 2019: https://www.envirojustice.org.au/wp-content/uploads/2019/11/Expert-Position-Statement-PDF.pdf, pp.6-7.

[40] Knibbs, Cortés de Waterman, Toelle, Guo, Denison, Jalaludin, Williams. (2018). The Australian Child Health and Air Pollution Study (ACHAPS): A national population based cross-sectional study of long-term exposure to outdoor air pollution, asthma, and lung function. Environment International, 120, 394-403; Bowatte, G., Lodge, C., Knibbs, L., Erbas, B., Perret, J., Jalaludin, B., Dharmage, S. (2018). Traffic related air pollution and development and persistence of asthma and low lung function. Environment International, 113, 170-176; Gauderman WJ, Urman R, Avol E, et al. (2015). 'Association of improved air quality with lung development in children'. NEJM 2015;372;10:905-913.

[41] Chen, Guo, Abramson, Williams, & Li. (2018). Exposure to low concentrations of air pollutants and adverse birth outcomes in Brisbane, Australia, 2003–2013. Science of the Total Environment, 622-623, 721-726; Li, S., Guo, Y., & Williams, G. (2016). Acute Impact of Hourly Ambient Air Pollution on Preterm Birth. Environmental Health Perspectives, 124(10), 1623-1629; Pereira, G. et al., Locally derived traffic-related air pollution and fetal growth restriction: a retrospective cohort study. Occupational and environmental medicine 2012, 69 (11), 815-822.

[42] Xu, Z. W. et al., Air pollution, temperature and paediatric influenza in Brisbane, Australia. Environment international 2013, 59, 384-388.

[43] Bowatte, G., et al., (2018). Traffic related air pollution and development and persistence of asthma and low lung function. Environment International, 113, 170-176; Bowatte, Lodge, Knibbs, Lowe, Erbas, Dennekamp, Dharmage. (2017). Traffic related air pollution exposure is associated with allergic sensitization, asthma, and poor lung function in middle age. The Journal of Allergy and Clinical Immunology,139(1), 122-129.e1.

[44] Wang, X., Hu, W., & Tong, S. (2009). Long-term exposure to gaseous air pollutants and cardio-respiratory mortality in Brisbane, Australia. Geospatial Health, 3(2), 257-263.

[45] Sunyer J, Esnaola M, Alvarez-Pedrerol M, Forns J, Rivas I, López-Vicente M, et al. (2015) Association between Traffic-Related Air Pollution in Schools and Cognitive Development in Primary School Children: A Prospective Cohort Study. PLoS Med 12(3): e1001792. https://doi.org/10.1371/journal.pmed.1001792

This section outlines the best available technologies for pollution control and timeframe for installing those controls to protect human and environmental health. We have included Victorian coal-fired power stations in this section to demonstrate that coordinated control of air pollution from coal-fired power stations in both states is possible.

3.1 Regulating emissions from coal-fired power stations

Australia's risk-based approach to air pollution regulation falls well short when compared with international counterparts.[46] For several decades the US, EU, South Korea, China, Japan and other nations have required increasingly effective controls for PM, NO_x, SO_2, and mercury.

Emissions from coal-fired power stations must be set at limits that require the installation of best available pollution control technologies (BACT) described below. Pollution licences must impose a range of obligations that, among other things, require pollution controls and power station infrastructure to be regularly maintained to ensure that operations are run as cleanly as possible. Because much of the $PM_{2.5}$ from combustion of coal is formed by subsequent reaction of SO_2 and NO_x in the atmosphere, BACT levels of SO_2 and NO_x pollution controls must be required to properly protect the public from adverse $PM_{2.5}$ health impacts.

Table 2: Emission levels that can be achieved with installation of BACT for existing coal-fired power stations[47]

	Annual Average (mg/m^3)	Short term (daily or reference test) (mg/m^3)
PM[48]	2-8	3-11
SO_2 & SO_3	10-130	25-165
NO_x (coal)	65-150	<85-165
NO_x (lignite)	<85-150	140-165
Hg (coal)	<1-4 ug/m^3	<1-4 ug/m^3
Hg (lignite)	<1-7 ug/m^3	<1-7 ug/m^3

Emissions limits in other countries for existing power stations retrofitted with BACT are in Table 3 below.

[46] Although the NSW regulatory frameworks require advances in pollution reduction to be made, this is not done.
[47] See: Commission Implementing Decision (EU) 2017/1442 of July 2017, establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants. *"BAT Associated Emission Levels, Section 2 "BAT Conclusions for the Combustion of Solid Fuels"*, https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1503383091262&uri=CELEX%3A32017D1442
[48] The EU Directive assigns slightly less stringent limits (2-10 mg/m^3; 3-11mg/m^3) to plants with a heat input of less than 1000 MW of thermal input (approximately 280-320 MW electric output).

Table 3: Representative emission limits for existing coal-fired power stations in other jurisdictions

	SO_2 (mg/m³)	NO_x (mg/m³)	PM (mg/m³)	Hg (ug/m³)
China[49]	35	50	10	30
Japan[50]	68.3	57.5	14.3	10
South Korea[51]	142.5.	102.5	10	50
EU[52]	130	150	8	2.0/4.0[53]
U.S.[54]	640	640	23	1.7/15.3[55]

Compare these limits to the current limits for coal-fired power stations in NSW in Table 4 below.

[49] 火电厂大气污染物排放标准/Emission standard of air pollutants for thermal power plants (GB 13223-2011). Partial English translation: https://english.mee.gov.cn/Resources/standards/Air_Environment/Emission_standard1/201201/W020110923324406748154.pdf, Full English translation available at: https://www.codeofchina.com/search/default.html?page=1&keyword=GB13223-2011
See also: http://www.mep.gov.cn/gkml/hbb/bwj/201512/W020151215366215476108.pdf

[50] Compilation of actual emissions values - 90th percentile shown: http://pubs.acs.org/doi/abs/10.1021/acs.est.6b03731

[51] See Air Environment Conservation Act Enforcement Regulations: http://www.law.go.kr/%EB%B2%95%EB%A0%B9/%EB%8C%80%EA%B8%B0%ED%99%98%EA%B2%BD%EB%B3%B4%EC%A0%84%EB%B2%95%20%EC%8B%9C%ED%96%89%EA%B7%9C%EC%B9%99

[52] COMMISSION IMPLEMENTING DECISION establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants. 28 Apr 2017. http://ec.europa.eu/transparency/regcomitology/index.cfm?do=search.documentdetail&Dos_ID=14177&DS_ID=50159&Version=1. See also: Industrial Emissions Directive, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075

[53] Higher limit is for lignite plants.

[54] See: http://www.gpo.gov/fdsys/pkg/FR-2012-02-16/pdf/2012-806.pdf; http://www.gpo.gov/fdsys/pkg/FR-2013-04-24/pdf/2013-07859.pdf; http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr60_main_02.tpl

[55] Higher limit is for lignite plants.

Table 4: Emission limits for existing coal-fired power stations in NSW

	SO_2 (mg/m³)	NO_x (mg/m³)	PM (mg/m³)	Hg (ug/m³)
Bayswater[56]	1700	1500	50	50
Eraring[57]	1700	1100	50	50
Liddell[58]	1900	1500	50	50
Mt Piper[59]	1700	1500	50	50
Vales Point[60]	1700	1500	50	50

If Australian power stations were fitted with the BACTs that are widely used in other countries the emissions limits set out in Table 5 below could be achieved.

Table 5: Proposed BACT Retrofit emission limits for coal-fired power stations in Australia

	Nominal Emission Limits (Subject to Revision based on individual power station operating data)	
	Annual Average (mg/m³)	Short term (daily or reference test) (mg/m³)
PMf[61]	5	8[62]
PMf+c	*NA*	40[63]
SO2 & SO3	70	100
NOx (coal)	100	120
NOx (lignite)	50	60
Hg (coal)	0.002	0.002
Hg (lignite)	0.004	0.004

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[56] See: https://apps.epa.nsw.gov.au/prpoeoapp/ViewPOEOLicence.aspx?DOCID=192609&SYSUID=1&LICID=779
[57] See: https://apps.epa.nsw.gov.au/prpoeoapp/ViewPOEOLicence.aspx?DOCID=192607&SYSUID=1&LICID=1429
[58] See: https://apps.epa.nsw.gov.au/prpoeoapp/ViewPOEOLicence.aspx?DOCID=192608&SYSUID=1&LICID=2122
[59] See: https://apps.epa.nsw.gov.au/prpoeoapp/ViewPOEOLicence.aspx?DOCID=194327&SYSUID=1&LICID=13007
[60] See: https://apps.epa.nsw.gov.au/prpoeoapp/ViewPOEOLicence.aspx?DOCID=192603&SYSUID=1&LICID=761
[61] Based on emissions data reported by the operator for Vales Point Plant: https://www.de.com.au/environment/environmental-licences-and-monitoring
[62] Ibid. See also: COMMISSION IMPLEMENTING DECISION establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants. 28 Apr 2017. http://ec.europa.eu/transparency/regcomitology/index.cfm?do=search.documentdetail&Dos_ID=14177&DS_ID=50159&Version=1
[63] Based on ratio of condensable to filterable emissions; USEPA data in MATS proceeding. Docket Number EPA-HQ-OAR-2009-0234-3038 "*Coal PM Floor Analysis*". Available at: https://www.regulations.gov/document?D=EPA-HQ-OAR-2009-0234-3038

NB: PMf refers to filterable fine particle pollution. PMf+c refers to filterable and condensable fine particle pollution.

Action: By September 2021, establish a comprehensive plan that sets out specific and enforceable obligations for coal-fired power station operators to achieve BACT emissions levels, including the following elements:

- BACT short and medium-term emissions limits for PM_{10}, $PM_{2.5}$, SO_2, NO_x, and Hg.
- Continuous emission monitoring (CEMS) for CO_2, PMf, SO_2, NO_x, and Hg, to be installed, maintained and operated, with real-time posting on a publicly available website.
- A requirement that CEMS be maintained and operated in accordance with international best practices, including annual relative accuracy test audits and quarterly relative accuracy audits.[64]
- Use of the U.S. National Institute of Standards and Technology (NIST) "non-nulling" or the equivalent reference method to measure stack flow rate of stack gases.[65]
- A maintenance plan, with specified replacement of parts at intervals based conservatively on prior maintenance history and on-site storage of critical components affecting emissions (such as filter bags, SO_2 and NO_x reagents).
- An immediate reduction in generation to the lowest level necessary to maintain grid stability and initiation of shutdown procedures for any malfunction that cannot be resolved within a specified period of time.
- The use of the cleanest available fuels during any period where a pollution control is not operational (e.g., before the unit reaches the operating temperature needed by its selective catalytic reduction (SCR)).
- Immediate reporting of any upset conditions to the agency and the public. The agency should thereafter investigate and post the results of its review.
- Shutdown of the unit if monitoring device availability falls below acceptable levels.

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[64] For example, the procedures required to be followed for CEMS in the US appear in 40. CFR part 60, Appendix F. i.e., https://www.law.cornell.edu/cfr/text/40/appendix-F_to_part_60
[65] A.N. Johnson, I.I. Shinder, B.J. Filla, J.T. Boyd, R. Bryant, M.R. Moldover, T.D. Martz & M.R. Gentry (2020) Faster, more accurate, stack-flow measurements, *Journal of the Air & Waste Management Association*, 70:3, 283-291: 10.1080/10962247.2020.1713249

Suggested installation schedule for coal-fired power stations in NSW and Victoria

Installing pollution controls in existing coal-fired power stations requires planning, both for power stations to prepare, contract, construct and test controls, and to ensure there is adequate electricity supply. This will require cooperation and scheduling between the operators and the Australian Energy Market Operator (AEMO).

In order to ensure adequate electricity supply during the "tie-in" period, that is, the time that it takes to bring pollution controls into the combustion process, specific retrofit dates should stagger installation of controls in the National Electricity Market (NEM). The schedule for taking units offline for installation and tie-in provides that this should happen in spring and autumn seasons when demand for electricity is lowest and there is (ordinarily) excess capacity in the NEM. The schedule limits installations to no more than one unit at any power station at any time and phases in the installation of those controls over several years.

There are several alternative approaches to scheduling the installation of pollution controls in NSW and Victoria. One option is to require each operator to control a set percentage of its generating capacity (nominally 25 percent) each year commencing three years after the date of regulatory or legislative changes to emissions limits. Another option is to set retrofit dates for specific plants, based on advice from AEMO, and policy preferences expressed in legislation or regulation. Among the policy choices is the issue of whether it is better to require control on the oldest or newest units. The schedule for installation below assumes that the newer units are chosen first. This is because newer units require lower maintenance, have less unplanned outages, and lower fuel costs. As such, newer units can be expected to run more and be dispatched more often, making the installation of pollution controls more effective in delivering the greatest pollution reduction.

Table 6: Suggested schedule for installation of pollution controls

State	Power Station	Coal type	Start of Operations	Capacity	Retrofit dates
NSW	Eraring	Black	1982-1984	4 x 720 MW	Spring 2024; Autumn 2025; Spring 2025; Autumn 2026
NSW	Bayswater	Black	1982-1984	4 x 660 MW	Spring 2025; Autumn 2026; Spring 2026; Autumn 2027
NSW	Liddell	Black	1971-1973	4 x 500 MW	N/A – retiring 2022
NSW	Mt Piper	Black	1993	2 x 700 MW	Spring 2024; Autumn 2025
NSW	Vales Point B	Black	1978	2 x 660MW	Spring 2026; Autumn 2027
VIC	Loy Yang A	Brown	1984-1987	3 x 560 MW 1 x 530 MW	Autumn 2025; Spring 2025; Autumn 2026; Spring 2026
VIC	Loy Yang B	Brown	1993-96	2 x 535 MW	Spring 2024; Autumn 2025

VIC	Yallourn W	Brown	1975-1982	2 x 375 MW 2 x 350 MW	Spring 2025; Autumn 2026; Spring 2026; Autumn 2027

4. Controlling pollution from mining for coal

Mining for coal is a major source of PM_{10} and $PM_{2.5}$ pollution in NSW.[66] Communities in the Upper Hunter Valley experience the greatest burden of air pollution from mining for coal. According to the NSW EPA, open cut coal mines are responsible for about 90 percent of coarse particle pollution (PM_{10}) in the Upper Hunter Region.[67] In 2019, residents in the Upper Hunter Valley received more than 1000 air pollution alerts when national air quality standards for PM_{10} were exceeded.[68] In 2018, a year without severe bush fires, six monitoring sites in the Upper Hunter Valley recorded PM_{10} concentrations that exceeded the annual standard of 25 µg/m3.[69] The village of Camberwell experienced 44 days where PM_{10} exceeded the 24-hour standard of 50 $\mu g/m^3$.[70] Every exceedance of the standards represents a threat to human health. Using World Health Organization figures, Upper Hunter GPs have estimated that PM_{10} pollution caused at least 160 premature deaths in the Upper Hunter between 2015 and 2019.[71]

Blast plumes from open cut mines are a public health threat.[72] A poorly conducted blast releases a cloud of highly concentrated nitrogen dioxide that can travel up to 5km before dispersing.[73] There

[66] NSW Air Emissions Inventory: https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/air/19p1917-air-emissions-inventory-2013.pdf?la=en&hash=9217ADF2C8D5647147FF00F447258319D00BB75D/.
[67] NSW EPA (2013) *NSW EPA submission to Senate Standing Committee on Community Affairs Inquiry into the Impacts on Health of Air Quality in Australia*, pp.11,15: https://www.environment.nsw.gov.au/resources/air/epasenateaqsub.pdf; NSW EPA (2013) Hunter Valley Annual Air Quality 2012 - Fine Particles. *NSW Environment Protection Authority*, Sydney.
[68] Louise Nichols, Record air quality alerts for the Upper Hunter in 2019 prompt renewed calls for a clean air strategy, *Singleton Argus*, 13 June 2020:https://www.singletonargus.com.au/story/6791773/calls-for-the-implementation-of-a-clean-air-strategy/
[69] NSW and Office of Environment and Heritage (OEH) 2019, *NSW Annual Air Quality Statement 2018*, Office of Environment & Heritage, Sydney, p.18, Figure 11: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Air/annual-air-quality-statement-2018-190031.pdf
[70] NSW and Office of Environment and Heritage (OEH) 2019, *NSW Annual Air Quality Statement 2018*, Office of Environment & Heritage, Sydney, p.18, Figure 11: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Air/annual-air-quality-statement-2018-190031.pdf
[71] Louise Nichols, We are studying the problem to death, quite literally, as particle pollution causes premature death, *Singleton Argus*, 19 November 2019: https://www.singletonargus.com.au/story/6499420/campaign-to-tackle-air-pollution; See: World Health Organization. Regional Office for Europe. (2006). Air quality guidelines global update 2005: particulate matter, ozone, nitrogen dioxide and sulfur dioxide – Summary of risk assessment. Copenhagen: WHO Regional Office for Europe, p.12: https://apps.who.int/iris/bitstream/handle/10665/69477/WHO_SDE_PHE_OEH_06.02_eng.pdf?sequence=1;
[72] See: https://www.health.nsw.gov.au/environment/factsheets/Pages/mine-blast-fumes.aspx
[73] Attalla, M., Day, S., Lange, T., Lilley, W. & Morgan, W. 2008. NOx emissions from blasting operations in open-cut coal mining. *Atmospheric Environment*, Volume 42, Issue 34:7874-7883: https://doi.org/10.1016/j.atmosenv.2008.07.008. See also: Mining Australia, 2011, "Blast fume events – addressing a noxious issue", Mining Australia, available at http://www.miningaustralia.com.au/features/blast-fume-eventsaddressing-a-noxious-issue

have been well documented cases of mine workers hospitalised after exposure despite being 3 to 5km from the blast, or members of the public becoming unwell after driving through a plume.[74]

The NSW EPA operates a monitoring and compliance program in the Hunter Valley to tackle excessive PM_{10} levels from coal mines, called *Operation Bust the Dust*.[75] The program inspects mines on hot, dry and windy days, to check that mines are implementing control procedures to minimise coarse particle pollution. These measures include watering unsealed roads, avoiding dust-generating activities during windy weather and minimising the impact of drilling operations. Previous iterations of the program, *Dust Stop* and *Dust Patrol* have been ineffective at reducing the number of exceedances in the Hunter Valley. In 2019 and 2020, the EPA found most mines "used adequate controls on mining activities".[76] However, the EPA also found that "due to the extremely dry and windy weather, dust was observed blowing off exposed areas on mine site".[77] If existing pollution control requirements are insufficient to control pollution, more must be done.

The EPA's enforcement powers and mechanisms should also be strengthened. This could include the issuing of stop work orders during periods of increased air pollution and unfavourable weather conditions, so that mining operations do not contribute to more dust in the air. In July 2019 the EPA fined the Mount Arthur open cut-coal mine, near Muswellbrook, $15,000 for causing excessive dust pollution on a windy day in October 2018.[78] It appears that Mount Arthur operators did not adapt its pollution control practice to minimise dust despite having received a January 2018 Penalty Notice for a similar alleged offence in 2017.[79] Such EPA compliance orders have been widely criticised by doctors and community leaders as insufficient to incentivise effective pollution control practices.[80]

Action: By September 2021, implement a comprehensive program to control coarse particle pollution from coal mines, with a focus on the Upper Hunter Valley, including the following elements:

- A cumulative impacts approach to new mining project assessments.

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[74] ABC News, 2013, "Upper Hunter miners exposed to toxic fumes," 20 September 2013, available at: http://www.abc.net.au/news/2013-09-20/upper-hunter-miners-exposed-to-toxicfumes/4972192; McCarthy J, 2014, "Mine blast gone wrong spews toxic cloud", Sydney Morning Herald, 21 February 2014, available at http://www.smh.com.au/environment/mine-blast-gonewrong-spews-toxic-cloud-20140221-335rf.html; Latimer, C., 2014, "Wambo coal mine fined over blast incident", Australian Mining, 8 August 2014, available at: https://www.australianmining.com.au/news/%e2%80%8bwambo-coal-mine-fined-over-blast-incident-2/; Kelly M, 2013, "Effects of mine blasts worry residents", Newcastle Herald, 12 May 2013.
[75] See: https://www.epa.nsw.gov.au/your-environment/air/regional-air-quality/tackling-coal-mine-dust
[76] https://www.epa.nsw.gov.au/your-environment/air/regional-air-quality/tackling-coal-mine-dust
[77] https://www.epa.nsw.gov.au/your-environment/air/regional-air-quality/tackling-coal-mine-dust
[78] https://www.epa.nsw.gov.au/news/media-releases/2019/epamedia190729-mount-arthur-coal-mine-fined-for-excessive-dust-emissions
[79] See: https://www.epa.nsw.gov.au/news/media-releases/2018/epamedia180117
[80] Goetze, E., 2019 "'Our pool is black': Residents in NSW's Upper Hunter vent air-pollution fears", ABC Upper Hunter, 25 October 2019, available at: https://www.abc.net.au/news/2019-10-25/air-quality-stokes-community-pollution-fears-in-nsw-upper-hunter/11638418; McCarthy, J., 2018, "Muswellbrook mayor slams latest pollution fine linked to Mount Arthur coal mine" Newcastle Herald, 18 January 2018, available at: https://www.newcastleherald.com.au/story/5172857/bhps-15000-dust-pollution-fine-shows-laws-dont-protect-communities/.

- Enforcing a 10km buffer zone between communities and new open cut mines.
- A ban on new mine project approvals in areas where air quality standards are already exceeded.
- An increase in the EPA's *Bust the Dust* program inspections and enforcement staff.
- Enforcement of stop work orders during periods of increased air pollution and unfavourable weather conditions.
- Substantially increased penalties for excessive dust emissions and inadequate pollution control practices.

Load Based Licensing

The 'polluter pays' principle dictates that those who generate pollution and waste should bear the cost of containment, avoidance or abatement.[81] The NSW Load-Based Licencing scheme requires polluters to pay licence fees based on the amount of the pollution produced. It provides a financial incentive for polluters to reduce their emissions of toxic pollution, adopt cleaner technologies, and to determine the most cost effective way of doing so. At present, coal mines are exempt from the Load-Based Licencing Scheme.[82]

The NSW Load-Based Licencing scheme has been under review since late 2016.[83] In redeveloping the Load-Based Licencing scheme, the NSW government should ensure that fees are set at a level that incentivises pollution reduction and internalises the cost of the pollution. For example, existing fees have not incentivised BACT installation from coal-fired power stations. It has been estimated using data from the Australian Academy of Technological Science and Engineering (ATSE) that licence fees would have to increase by a factor of almost 50 to properly internalise the health costs created by the NSW power stations.[84]

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[81] *Protection of the Environment Administration Act 1991* (NSW) s. 6(2)d)(i).
[82] NSW Environment Protection Authority (2016) *Review of the Load-based Licensing Scheme Issues paper*, NSW Environment Protection Authority, Sydney, pp.16-17: https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/licensing/lbl/load-based-licensing-review-issues-paper-150397.pdf
[83] NSW Environment Protection Authority (2016) *Review of the Load-based Licensing Scheme Issues paper*, NSW Environment Protection Authority, Sydney: https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/licensing/lbl/load-based-licensing-review-issues-paper-150397.pdf
[84] Doctors for the Environment Australia (2016) Submission to NSW EPA on the Review of the loadbased licensing scheme, December 2016, p.6: https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/licensing/lbl/lbl-issues-paper-doctors-for-the-environment.pdf?la=en&hash=6C115A77E8F9BB507FEC7C6CF8EA0AF20BFEC42F; Biegler T. (2009), The Hidden Costs of Electricity: Externalities of Power Generation in Australia. Australian Academy of Technological Science and Engineering: https://www.atse.org.au/wp-content/uploads/2019/01/the-hidden-costs-of-electricity.pdf; Ewald, B. (2018), The value of health damage due to sulphur dioxide emissions from coal-fired electricity generation in NSW and implications for pollution licences. Australian and New Zealand Journal of Public Health, 42: 227-229. https://doi.org/10.1111/1753-6405.12785

Action: By September 2021, update the Load-Based Licencing scheme to incentivise pollution reductions from industry, including the following elements:

- Removal of the licence fee exemption for pollution emitted by coal mines and associated infrastructure (trucks, conveyors, load-out facilities and trains).
- Increase licence fees to a level that internalises the health costs of pollution.
- Remove the fee rate threshold so the cost of a unit of pollution is consistent and not determined by source.

5. Controlling pollution from motor vehicles and transport

Across the NSW GMR on-road mobile sources account for 15 percent of NO_2 and 1.7 percent of $PM_{2.5}$, but in Sydney where the greatest population lives the proportions are 53 percent of NO_2 and 9.3 percent of $PM_{2.5}$.[85] In 2005, the health costs of motor vehicle pollution across Sydney were estimated to be $1.5 billion per year.[86] Modern vehicles are much cleaner than older vehicles, but there is no systematic mechanism to remove highly polluting vehicles from the road fleet. This is a problem for people living, working or travelling on busy roads, which is potentially amplified by the growing number of road tunnels.

Australia has the lowest rank out of the 35 OECD countries for fuel quality.[87] Diesel vehicles emit much higher amounts of NO_x than petrol vehicles. Many OECD countries and cities are phasing out diesel vehicles due to the health impacts associated with diesel emissions.[88] Rather than acting in a manner consistent with its OECD counterparts, Australia is increasing the amount of diesel vehicles on its roads.[89] California and other US state regulators now recognise diesel particulate matter (DPM) as a special class of particulates. More than 90 percent of fine particle pollution from diesel combustion is less than 1 micrometre in diameter, a subset of $PM_{2.5}$ that is considered even more toxic. In 2012, the World Health Organization's International Agency for Research on Cancer (IARC)

[85] NSW Environment Protection Authority (2019) Air Emissions Inventory for the Greater Metropolitan Region in New South Wales: 2013 Calendar Year Consolidated Natural and Human-Made Emissions, October 2019, p.82, Figures 3-11 and 3-12: https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/air/19p1917-air-emissions-inventory-2013.pdf
[86] Bureau of Transport and Regional Economics (BTRE) 2005, *Health Impacts of Transport Emissions in Australia: Economic Costs*, Working Paper No. 63, Bureau of Transport and Regional Economics, Department of Transport and Regional Services, Canberra: www.bitre.gov.au/publications/2005/wp_063.aspx
[87] Schofield, R., Walter ,C., Silver ,J., Brear ,M., Rayner ,P., Bush, M (2017), 'Submission on the "Better fuel for cleaner air" discussion paper'. Melbourne: Clean Air and Urban Landscapes Hub/Melbourne Energy Institute.
[88] Garfield L. (2017) 13 cities that are starting to ban cars. Business Insider Australia. Available at: https://www.businessinsider.com.au/cities-going-car-free-ban-2017-8?r=US&IR=T.
[89] Cames, M. & Helmers, E. Environ Sci Eur (2013) 25: 15. https://doi. org/10.1186/2190-4715-25-159.

released its research assessing the health impacts of air pollution from diesel.[90] IARC's extensive literature review led to the conclusion that diesel engine exhaust is "carcinogenic to humans".[91]

In order to reduce air pollution from vehicle emissions, governments in Britain and the European Union created "Clean Air Zones", or "Low Emission Zones".[92] These Zones are established in densely populated areas, particularly near vulnerable community locations such as schools and childcare centres. Clean Air Zones implement a "polluter pays" principle by imposing a fee on polluting vehicle operators who drive within or through the Zone. The fee can be initially targeted at diesel freight trucks and be increased progressively to include other forms of vehicles. Between February 2017 and February 2020, there has been a 39 micrograms per cubic metre reduction in roadside concentrations of nitrogen dioxide in London's Ultra Low Emissions Zone (ULEZ), a reduction of 44 percent.[93] The London ULEZ scheme contains fee exemptions for residents, vehicle operators with a disability, taxis, and other not-for-profit community uses such as school transport to ensure that it is an equitable policy that does not adversely affect the everyday people whose health the scheme is designed to protect.[94]

Idling – running a vehicle's engine while it is stationary – can also lead to poor local air quality with serious health risks, particularly for vulnerable populations. In the United States, idling has been identified as a significant factor in higher pollution levels in and around schools.[95] More than 23 US states limit vehicle idling by some or all vehicles.[96] Eighteen US states implement schemes involving grants, loans, or tax credits to provide incentives for adopting idle reduction technologies for heavy vehicles. Significant child health improvements have been associated with the Californian EPA policies that reduced children's exposure to traffic-related air pollution (TRAP).[97] The Californian EPA policies

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[90] Debra T. Silverman, Claudine M. Samanic, Jay H. Lubin, Aaron E. Blair, Patricia A. Stewart, Roel Vermeulen, Joseph B. Coble, Nathaniel Rothman, Patricia L. Schleiff, William D. Travis, Regina G. Ziegler, Sholom Wacholder, Michael D. Attfield, The Diesel Exhaust in Miners Study: A Nested Case–Control Study of Lung Cancer and Diesel Exhaust, JNCI: Journal of the National Cancer Institute, Volume 104, Issue 11, 6 June 2012, Pages 855–868, https://doi.org/10.1093/jnci/djs034; Michael D. Attfield, Patricia L. Schleiff, Jay H. Lubin, Aaron Blair, Patricia A. Stewart, Roel Vermeulen, Joseph B. Coble, Debra T. Silverman, The Diesel Exhaust in Miners Study: A Cohort Mortality Study With Emphasis on Lung Cancer, *JNCI: Journal of the National Cancer Institute*, Volume 104, Issue 11, 6 June 2012, Pages 869–883, https://doi.org/10.1093/jnci/djs035

[91] World Health Organization (WHO) 2012, *Media Release No. 213, IARC: Diesel Engine Exhaust Carcinogenic*, International Agency for Research on Cancer, World Health Organization, Lyon, France: www.iarc.fr/wp-content/uploads/2018/07/pr213_E.pdf

[92] For example, see: https://www.gov.uk/guidance/driving-in-a-clean-air-zone; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/863730/clean-air-zone-framework-feb2020.pdf.

[93] See: https://www.london.gov.uk/sites/default/files/ulez_ten_month_evaluation_report_23_april_2020.pdf.

[94] See: https://tfl.gov.uk/modes/driving/ultra-low-emission-zone/discounts-and-exemptions

[95] J. Richmond-Bryant, L. Bukiewicz, R. Kalin, C. Galarraga, F. Mirer, A multi-site analysis of the association between black carbon concentrations and vehicular idling, traffic, background pollution, and meteorology during school dismissals, *Science of The Total Environment*, Volume 409, Issue 11, 2011, Pages 2085-2093, https://doi.org/10.1016/j.scitotenv.2011.02.024

[96] Riley Hutchings and Kim Tyrrell, Putting the Brakes on Idling Vehicles, *National Conference of US State Legislatures* Vol . 26, No. 34 / September 2018. Available at: https://www.ncsl.org/research/environment-and-natural-resources/putting-the-brakes-on-idling-vehicles.aspx

[97] Gauderman WJ, Urman R, Avol E, Berhane K, McConnell R, Rappaport E, et al. Association of improved air quality with lung development in children. *New England Journal of Medicine*. 2015, 372(10):905-13: https://www.nejm.org/doi/10.1056/NEJMoa1414123.

resulted in the development of larger, healthier lungs in children, with health benefits that extend into adulthood, including a reduced risk of cardiovascular disease and associated mortality.

Vehicle emissions can be reduced by other mechanisms, including by implementing Euro 6 standards for passenger and light vehicles, and Euro V1 standards for heavy vehicles. The EU has consistently reviewed its vehicle emissions standards of both petrol and diesel vehicles to drive down NO_x emissions.[98] The most recent standard imposed an emission reduction limit for light diesel vehicles of 56 percent, from 0.18 g/km (Euro 5 Standard) to 0.08 g/km (Euro 6).[99] A significant factor in the success of reducing NO_x emissions from vehicles is using fuels with very low sulfur content.[100] Europe commenced phasing-in virtually sulfur-free petrol and diesel fuels – less than 10ppm – in 2005. Australia currently implements the less-stringent Euro 5 standards for light and heavy vehicles.[101] The Ministerial Forum on Vehicle Emissions is currently undertaking a review to consider whether Australia should adopt the Euro 6 Standards for light vehicle and Euro VI standards for heavy vehicles. Fuel standards are set the federal level,[102] however the Ministerial Forum on Vehicle Emissions review is a good opportunity for the NSW government to make submissions on the necessity of adopting the Euro 6 standards.

The rail sector is another source of uncontrolled air pollution in NSW.[103] Rail freight lines run through densely populated suburbs exposing many people to toxic diesel exhaust. Europe and the United States have had locomotive emissions standards for in place for two decades.[104] The US EPA rule cuts PM emissions from these engines by as much as 90 percent, NOx emissions by as much as 80 percent, and reduces idling from locomotives.[105]

Action: By September 2021, develop a comprehensive plan to reduce vehicle pollution, with a focus on vehicle pollution hotspots, including the following elements:

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[98] For a history of vehicle emissions reductions in the EU, and elsewhere, see: https://www.transportpolicy.net/topic/efficiency-and-ghg-standards/.
[99] International Council of Clean Transportation, A Technical Summary of Euro 6/VI Vehicle Emission Standards (2016) p.3. Available at: https://theicct.org/sites/default/files/publications/ICCT_Euro6-VI_briefing_jun2016.pdf.
[100] International Council of Clean Transportation, A Technical Summary of Euro 6/VI Vehicle Emission Standards (2016) p.2. Available at: https://theicct.org/sites/default/files/publications/ICCT_Euro6-VI_briefing_jun2016.pdf.
[101] *Vehicle Standard (Australian Design Rule 79/04 — Emission Control for Light Vehicles) 2011*, made under s7 of the *Motor Vehicle Standards Act 1989; Vehicle Standard (Australian Design Rule 80/03 - Emission Control for Heavy Vehicles) 2006*, made under made s7(1) of the *Motor Vehicle Standards Act 1989.*
[102] *Fuel Quality Standards (Petrol) Determination 2019* (Cth)*; Fuel Quality Standards (Automotive Diesel) Determination 2019* (Cth).
[103] See: https://www.epa.nsw.gov.au/your-environment/air/non-road-diesel-marine-emissions/reducing-diesel-emissions-locomotives
[104] Directive 2004/26/EC of the European Parliament and Council: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:146:0001:0107:EN:PDF; US Environmental Protection Agency, 1998, 40 CFR Parts 85, 89 and 92, Emission Standards for Locomotives and Locomotive Engines, US Federal Register of Rules and Regulations, Vol. 63, No. 73, 16 April 1998: https://www.govinfo.gov/content/pkg/FR-1998-04-16/pdf/98-7769.pdf.
[105] See: https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-emissions-locomotives

- Low emissions/clean air zones targeting diesel freight trucks in high-traffic urban areas.
- Anti-idling regulations to require engines be stopped when a vehicle is stationary for more than 1 minute, particularly near vulnerable community locations such as schools and childcare centres.
- Incentives for freight operators to upgrade to Euro 6/VI compliant vehicles.
- Introduction of US Tier 2 emissions standards for locomotives.

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6. Controlling pollution from domestic solid fuel burning

Solid fuel burning - that is, wood-burning heaters - significantly impacts local air quality throughout NSW.[106]

The principle control measures for wood heater pollution include: regulating the use of existing wood heaters, phasing out wood heaters in residential areas, and offering incentives to upgrade insulation and install clean heat pumps. Numerous states in the US have enacted regulations that phase out wood heaters, or ban solid fuel burning outright during periods of increased air pollution risk or unfavourable weather conditions.[107] Some US state building codes also prohibit the construction of homes that rely on solid fuel as a heating source.[108] These control measures are most effective when accompanied by public education and communication about the health risks associated with wood smoke.[109]

Australia's most successful wood smoke-reduction program was in Launceston, Tasmania. The program focused on public communications about the health impacts of wood smoke pollution and replacing wood heaters with clean heating alternatives. About 2,000 households received subsidies of $500 to remove wood heaters, while many more households replaced wood heaters with clean heating alternatives entirely at their own expense.[110] These interventions dramatically accelerated a general trend towards using heat pumps rather than wood heaters. As such, wood heater prevalence

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[106] See, for example, the NSW EPA Upper Hunter Wood Smoke Community Research Project: https://www.epa.nsw.gov.au/your-environment/air/reducing-wood-smoke-emissions/upper-hunter-wood-smoke-community-research-project.

[107] Modelling of air pollution may conclude that, if solid fuel appliances are permitted, the city or town will violate air quality standards, so the bans or restrictions are imposed as preventative measures to maintain compliance.

[108] See, for example: Washington State Energy Code, Sections R303.10.2 and R303.10.3: https://up.codes/viewer/washington/irc-2015/chapter/3/building-planning#R303

[109] See: Databuild Research & Solutions, 2016, *Upper Hunter Wood Smoke Community Research Project Final Report*, NSW Environment Protection Authority, Sydney: https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/woodsmoke/UHWSCR-consultant-report.ashx; Johnston, F., Hanigan, I., Henderson S., Morgan G., *Evaluation of interventions to reduce air pollution from biomass smoke on mortality in Launceston, Australia: retrospective analysis of daily mortality, 1994-2007 BMJ* 2013; 346: https://doi.org/10.1136/bmj.e8446

[110] Robinson, D.L. What makes a Successful Woodsmoke-Reduction Program? *Air Quality and Climate Change* 2016, 50, 20-28.

fell from 66 percent to 30 percent of all households and average particulate air pollution during winter was reduced by 40 percent (44 µg/m³ – 27 µg/m³).[111] This reduced wintertime deaths from respiratory disease by 28 percent and cardiovascular disease deaths by 20 percent.[112] Year round, for men, the reductions were 23 percent (respiratory), 18 percent (cardiovascular) and 11.4 percent (all deaths).[113]

The 2019 'Clean Air Plan for Sydney' authored by 35 expert air pollution scientists recommended legislation that works towards eliminating the use of wood heaters in urban areas.[114] One way to achieve this is to require wood heaters be removed when houses are sold. A 2011 consultancy report by AECOM Australia Pty Ltd for the NSW Office of Environment and Heritage concluded that a wood heater phase out, which banned the installation new wood heaters and required existing ones to be removed when houses are offered for sale, would yield the greatest cost-benefit of all wood smoke control measures, delivering a net-benefit of over $7.1 billion out to 2030.[115]

Action: By September 2021, implement a plan to phase-out wood heaters, including the following elements:

- Progressive restrictions on the use of wood heaters during periods of increased air pollution risk and/or unfavourable weather conditions.
- Require the removal of wood heaters from homes upon sale.
- Subsidise insulation upgrades and heat pump installations for houses that remove wood heaters.
- Phase out the installation of wood heaters.

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[111] Johnston Fay H, Hanigan Ivan C, Henderson Sarah B, Morgan Geoffrey G. Evaluation of interventions to reduce air pollution from biomass smoke on mortality in Launceston, Australia: retrospective analysis of daily mortality, 1994-2007 *BMJ* 2013; 346: https://doi.org/10.1136/bmj.e8446
[112] Johnston Fay H, Hanigan Ivan C, Henderson Sarah B, Morgan Geoffrey G. Evaluation of interventions to reduce air pollution from biomass smoke on mortality in Launceston, Australia: retrospective analysis of daily mortality, 1994-2007 *BMJ* 2013; 346: https://doi.org/10.1136/bmj.e8446
[113] Johnston Fay H, Hanigan Ivan C, Henderson Sarah B, Morgan Geoffrey G. Evaluation of interventions to reduce air pollution from biomass smoke on mortality in Launceston, Australia: retrospective analysis of daily mortality, 1994-2007 *BMJ* 2013; 346: https://doi.org/10.1136/bmj.e8446
[114] Paton-Walsh, C.; Rayner, P.; Simmons, J. et al. A Clean Air Plan for Sydney: An Overview of the Special Issue on Air Quality in New South Wales. *Atmosphere* 2019, *10*, 774.
[115] AECOM Australia Pty Ltd, *Economic Appraisal of Wood Smoke Control Measures*, NSW Office of Environment and Heritage, 29 June 2011. Accessed via: https://www.environment.nsw.gov.au/resources/air/WoodsmokeControlReport.pdf

7. Controlling ozone pollution

Ozone (O_3) is a secondary pollutant – it is ordinarily not emitted directly by industrial process such as burning coal or by vehicles.[116] Ozone is a colourless gas formed when NO_x and volatile organic compounds (VOC) react in sunlight. VOCs are a class of chemicals used across and emitted by many sources, including hydrocarbons from vehicle exhaust pipes.

Unhealthy concentrations of O_3 can form at considerable distances from direct sources of pollution, increasing the risk of unhealthy exposure to ozone in air that does not have industrial sources of air pollution or heavy traffic.

As explained above, O_3 impacts the airways and lungs, increasing susceptibility to lung infections and aggravating lung diseases. O_3 also reduces the photosynthesis and growth of certain agriculture crops and flora, increasing the risk of disease and insect damage.[117]

The best strategy to reduce ozone concentrations is to reduce NO_x and VOC emissions. Reducing NO_x emissions from large sources of NO_x emissions such as coal-fired power stations by installing SCR has the co-benefit of reducing both O_3 and $PM_{2.5}$. However, reducing NO_x alone does not automatically reduce O_3, and can in fact increase O_3. Aggressive air pollution controls have been implemented in China to reduce NO_x emissions, but significant ozone concentrations are pervasive and increasing.[118] The best way to reduce O_3 is for integrated pollution controls to be implemented that reduce NO_x and VOCs.

7.1 Reducing VOCs

There are a range of specific VOC emission control methods to reduce the diverse sources and composition of VOCs by combining several of the following:[119]

- **Improve work practice standards** by requiring VOC capture into hood or duct work to minimise fugitive emissions.

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[116] This section focuses on ground level, or tropospheric, ozone, which is distinguished from stratospheric ozone that protects us from the harmful ultraviolet effects of the sun's rays. A good mnemonic to distinguish the two types of ozone is: "Ozone in the blue is good for you. Ozone on the ground will get you down."
[117] Avnery, Shiri, et al., 'Global crop yield reductions due to surface ozone exposure: 2. Year 2030 potential crop production losses and economic damage under two scenarios of O_3 pollution' (2011) 45 *Atmospheric Science* 2297.
[118] University of Colorado at Boulder, Cooperative Institute for Research in Environmental Sciences, 2018, "China is Hot Spot of Ground-Level Ozone Pollution". Retrieved from https://cires.colorado.edu/news/china-hot-spot-ground-level-ozone-pollution; Ke Li, *et al.,* "Anthropogenic Drivers of 2013-2017 Trends in Summer Surface Ozone in China", 2019. Proceedings of the National Academy of Sciences. Retrieved from: https://www.pnas.org/content/116/2/422; [118] Clean Air Asia, "China Air 2019: Air Pollution Prevention and Control Progress in Chinese Cities". Nationally, annual average ozone concentrations increased from 149 ug/m^3 in 2017 to 151 ug/m^3 in 2018.
[119] See: U. S. Environmental Protection Agency, *Generic Chemical Rules for Stationary Sources of Air Pollution*: https://www.epa.gov/stationary-sources-air-pollution/generic-chemical-rules-stationary-sources-air-pollution; R. Avery, *"Reactivity-Based VOC Control for Solvent Products: More Efficient Ozone Reduction Strategies",* 2006. Environmental Science and Technology. Volume 40, pages 4845-4850: https://pubs.acs.org/doi/pdf/10.1021/es060296u?rand=umc9039z&

- **Pollution prevention techniques** requiring a switch from more hazardous or reactive chemical to a less hazardous or water-based product, or requiring fewer chemicals in the manufacturing process.
- **Limit emissions for each sector** expressed as kilograms of VOC per litre or kilogram of product applied.
- **Limit vapour pressure of petrol** especially during warm summer months, to reduce evaporative losses during the filling of storage tanks and refuelling of vehicles.
- **Minimum percentage** capture and destruction efficiency in an incinerator, expressed as minimum 95 percent capture, destruction and removal efficiency of VOC emissions.

7.2 Reducing NO_x

In addition to NO_x pollution controls that must be installed in coal-fired power stations described above, other combustion processes, industrial boilers and vehicle NO_x emissions can be controlled by:

- **Improving combustion efficiency**, keeping the boiler or vehicle well maintained and tuned to optimal performance standards;
- **Reducing combustion temperature** to lower NO_x emissions, ensuring that boilers are tuned to prevent increase of carbon monoxide concentrations;
- **Reducing the sulfur content in fuel** for installing catalytic devices that can effectively control NO_x emissions. High sulfur poisons catalysts, rendering them less effective, decreasing their operating life, and increasing maintenance costs;
- **Installing selective catalytic reduction** in industrial facility boilers and solid waste incinerators which can reduce NO_x emissions by 90 percent or higher.

Action: By September 2021, require industry emission standards for VOCs and NO_X consistent with best international practices, including the following elements:

- A requirement for leak detection systems to be installed on all oil refineries and gas plants to reduce VOC emissions.[120]
- VOC emissions limits and capture efficiency targets by sector.[121]
- A requirement for the installation of SCR technology on all industrial boiler facilities.

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[120] See: U. S. Environmental Protection Agency, *Leak Detection and Repair: A Best Practices Guide*: https://www.epa.gov/sites/production/files/2014-02/documents/ldarguide.pdf
[121] See: U. S. Environmental Protection Agency, *Generic Chemical Rules for Stationary Sources of Air Pollution*: https://www.epa.gov/stationary-sources-air-pollution/generic-chemical-rules-stationary-sources-air-pollution

8. National ambient air standards

The *National Environment Protection (Ambient Air Quality) Measure* (the NEPM) is intended to provide a nationally consistent framework for monitoring and reporting on ambient air quality. The NEPM is reflected in state law through regulations.[122] The monitoring and reporting functions of the NEPM in NSW are carried out by the EPA. Ambient air monitors owned and operated by EPAs are largely implemented in order for states to fulfil their monitoring and reporting obligations under the NEPM.

NEPM standards must be set at a level where air pollution exposure is reduced as far as possible. In 2015, Australia adopted a standard for annual $PM_{2.5}$ at 8µg/m^3.[123] The NSW government should ensure that the NEPM for annual $PM_{2.5}$ is lowered to 7µg/m^3 and 24-hour $PM_{2.5}$ is lowered to 20µg/m^3, as proposed in the 2015 amendment.[124]

Ambient air quality standards for the other key pollutants that reflect a minimum adverse impact on human health as agreed on by Australian health professional are as follows:[125]

Table 7: Recommended safe ambient air quality standards to protect health

Standard (in parts per billion)	Limit
SO_2 1-hour	60 (as 99th centile of daily worst hour)
SO_2 24-hour	8 (no exceedances)
NO_2 1-hour	72 (as 99th centile of daily worst hour)
NO_2 annual	9 (no exceedances)
O_3 1-hour	70

The NSW government must also commence monitoring, assessment and reporting of Upper Hunter air pollution under the NEPM. Section 3 of the NEPM requires New South Wales to monitor, assess and report a range of air pollution indicators. The population of The Upper Hunter Valley region (which in the 2016 Urban Centre and Locality statistical level totalled 30,658) significantly exceeds the 25,000 population threshold to trigger the mandatory monitoring, assessment and reporting of air pollution under the NEPM AAQ.

[122] In NSW: *National Environment Protection Measure (NSW) Act 1995* (NSW).
[123] Variation to the National Environment Protection (Ambient Air Quality) Measure 2015: https://www.legislation.gov.au/Details/F2016L00084. See also: https://www.nepc.gov.au/resource/variation-ambient-air-quality-nepm-%E2%80%93-particles-standards
[124] Variation to the National Environment Protection (Ambient Air Quality) Measure 2015: https://www.legislation.gov.au/Details/F2016L00084. See also: https://www.nepc.gov.au/resource/variation-ambient-air-quality-nepm-%E2%80%93-particles-standards
[125] Clare Walter, Maxwell Smith et al. (2019) Health-based standards for Australian regulated thresholds of nitrogen dioxide, sulfur dioxide and ozone: Expert Position Statement 2019: https://www.envirojustice.org.au/wp-content/uploads/2019/11/Expert-Position-Statement-PDF.pdf

Action: By September 2021, legislate ambient air quality standards for SO_2, NO_2 and O_3 to the values in Table 7, and regulate key emissions point-sources to ensure they are met.

Action: Periodically review the ambient standards based on epidemiological data, and revise/strengthen as appropriate. At a minimum, this should be completed every 5-7 years.

Action: Integrate the Upper Hunter Monitoring Network into NSW NEPM reporting.

9. Timeframes and targets

Timeframes and targets to achieve reduction in air pollution to best practice control standards must be set by the NSW government. Each airshed has unique characteristics based on the source of air pollution, the geography of the area, and meteorological patterns. These characteristics inform the types of air pollution control measures that should be adopted, the emissions reduction framework that is required, and factor for the meteorological conditions that can exacerbate pollutant concentrations.

To develop the air pollution reduction target for a given airshed the following questions must be answered:

- What levels of pollution reduction are required?
- How many tonnes of pollution must be removed from the airshed in order to meet (and sustain) health-based ambient air pollution standards?
- Based on economic forecasts, how will the mix of air pollution sources change in the future?
- What do these changes suggest for the need to adopt more stringent standards and control measures in the future to maintain compliance with ambient pollution standards?
- What control measures might provide concurrent reductions of many pollutants?

The timeframe to achieve reduction targets also varies by airshed, pollutants, and the mix of sources that contribute to pollution. Pollutant concentrations that are much higher than public health standards require more time to achieve than concentrations that are just above those standards.

Establishing timeframes to reduce pollution helps to provide transparency to the public. Timeframes are important for businesses who produce air pollution to meet stronger standards by planning for the installation of pollution controls.