



Department of Planning and Environment

# NSW Clean Air Strategy

2021-2030



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## Minister's message



**The Honourable James Griffin MP, Minister for Environment and Heritage**

New South Wales has a strong policy and regulatory framework that has achieved substantial air quality improvements over recent decades.

The NSW Government has also brought forward major new initiatives that tackle some of the State's biggest air pollution sources and improve air quality and health for our cities and regions.

The Net Zero Plan, NSW Electricity Strategy, NSW Electricity Infrastructure Roadmap, Hydrogen Strategy and Electric Vehicles Strategy will support new forms of energy and transport that mean fresh opportunities and cleaner air for all New South Wales.

Air pollution still occurs in NSW cities and regions and ongoing action remains vital to keep ahead of the curve, as forces such as growth and climate change increase pressures on air quality.

Activities we undertake every day affect the air we breathe. How we travel and heat our homes and the industries producing our goods and services emit a range of air pollutants that can affect our health. We can also be exposed to harmful levels of air pollution during extreme events such as bushfires and dust storms.

The NSW Clean Air Strategy, 2021–2030 therefore includes actions for:

- better preparedness for pollution events
- cleaner industry
- cleaner transport, engines and fuels
- healthier households
- better places.

Actions to manage community exposure to pollution, day-to-day and during events such as bushfires, will bring immediate health gains. Ongoing emission reductions from priority sources, and planning and place design that help protect people from pollution will deliver long-term wins.

The actions in the Clean Air Strategy are strongly grounded in the health, scientific and economic evidence on where we can achieve the greatest benefits. The NSW Government will continue building the knowledge and expertise to support our air quality policies.

The strategy takes account of public and stakeholder consultation, including submissions on the draft Clean Air Strategy. A number of initiatives will also have their own consultation process, giving stakeholders a further opportunity to engage in delivering cleaner air.

I am committed to actions and technologies that will improve air quality, while enabling people to maintain their way of life. Together we will keep working to clean the air and protect people's health in cities and regions throughout New South Wales.

# Contents

List of figures	v
Shortened forms	vi
How New South Wales manages air quality and its impacts	1
Effects of air quality on health	4
Actions to improve outcomes for air quality and health	5
1. Better preparedness for pollution events	5
2. Cleaner industry	10
3. Cleaner transport, engines and fuels	19
4. Healthier households	25
5. Better places	27
Keeping track	30
Working together towards cleaner air	31
References	32
Appendix: Information supporting the Clean Air Strategy	33
Monitoring	33
Pollution sources	39
Exposure	42
Health impacts	43
Further information	45
References	45

## List of figures

Figure 1	NSW air quality monitoring network	2
Figure 2	Expansion and upgrading of air quality monitoring and communication during the 'Black Summer' fires of 2019–20	9
Figure 3	Projected change in NSW electricity generation mix (gigawatt hours) as per 2020 Integrated System Plan	12
Figure 4	Past and projected reduction in PM <sub>2.5</sub> emissions (tonnes/year) and electricity generated from coal (gigawatt hours/year) based on 2020 Integrated System Plan	13
Figure 5	Integrated NSW Hydrogen Economy	17
Figure 6	NSW air quality trends, 1997–2020: annual average fine particle (PM <sub>2.5</sub> ), ozone (O <sub>3</sub> ) and nitrogen dioxide (NO <sub>2</sub> ) concentrations	34
Figure 7	Air quality in Sydney sub-regions and NSW regions, 2010–2020	35
Figure 8	Number of PM <sub>2.5</sub> exceedance days in NSW regions, 1997–2020	36
Figure 9	Number of PM <sub>10</sub> exceedance days in NSW regions, 1997–2020	36
Figure 10	Number of ozone (O <sub>3</sub> ) exceedance days in the Greater Metropolitan Region, 1997–2020	37
Figure 11	Air quality days in hazardous category, 2019	38
Figure 12	Predicted increase in severe fire days (i.e. days with Forest Fire Danger Index, FFDI, >50), 2060–2079	38
Figure 13	Contribution of human-made and natural sources to annual emissions in the NSW Greater Metropolitan Region (GMR)	39
Figure 14	Top primary human-made sources of fine particle (PM <sub>2.5</sub> ) emissions (tonnes/year) in NSW Greater Metropolitan Region in 2013	40
Figure 15	Top primary human-made sources of fine particle (PM <sub>2.5</sub> ) emissions (tonnes/year) in Sydney in 2013	40
Figure 16	Nitrogen oxides (NO <sub>x</sub> ) (tonnes/year) were one of the top sources of ozone and fine particle forming pollutants in NSW Greater Metropolitan Region in 2013	41
Figure 17	Volatile organic compounds (VOCs) (tonnes/year) were one of the top sources of ozone and fine particle forming pollutants in NSW Greater Metropolitan Region in 2013	41
Figure 18	Sulfur dioxide (SO <sub>2</sub> ) (tonnes/year) was one of the top sources of ozone and fine particle forming pollutants in NSW Greater Metropolitan Region in 2013	42
Figure 19	Greater Metropolitan Region population-weighted annual average PM <sub>2.5</sub> exposure in 2013	43
Figure 20	Total estimated years of life lost per annum for major sources of human-made particle pollution in the GMR	44

## Shortened forms

Term	Meaning
AEMO	Australian Energy Market Operator
Air NEPM	National Environment Protection (Ambient Air Quality) Measure – establishes national ambient air quality standards and a national framework for the monitoring and reporting of six common air pollutants, including particulate matter (PM), ozone (O <sub>3</sub> ), nitrogen dioxide (NO <sub>2</sub> ) and sulfur dioxide (SO <sub>2</sub> )
CBD	Central business district
CSIRO	Commonwealth Scientific and Industrial Research Organisation
The department	NSW Department of Planning and Environment
DPE	NSW Department of Planning and Environment (for in text citations and references)
enHealth	Environmental Health Standing Committee
EPA	NSW Environment Protection Authority
GMR	Greater Metropolitan Region – includes the major metropolitan areas of Sydney, Newcastle, Wollongong and Central Coast and adjacent non-urban areas
GREP	NSW Government Resource Efficiency Policy
LBL scheme	Load-based licensing scheme
MaaS	Mobility-as-a-service
NO <sub>2</sub>	Nitrogen dioxide
NO <sub>x</sub>	Nitrogen oxides
O <sub>3</sub>	Ozone
PIPAP	NSW Primary Industries Productivity and Abatement Program
PM	Particulate matter
POEO	Protection of the Environment Operations
POEO Act	<i>Protection of the Environment Operations Act 1997</i>
RFS	Rural Fire Service
SO <sub>2</sub>	Sulfur dioxide
VOC	Volatile organic compound
NZIIP	NSW Net Zero Industry and Innovation Program



## How New South Wales manages air quality and its impacts

Air quality in New South Wales is generally comparable with other Australian jurisdictions and relatively clean by world standards. The NSW Government works at the national, state, regional and local level through a framework of legislation, policies and programs to continue to improve air quality across the State. This work is led at an agency level by the Department of Planning and Environment (the department) and the Environment Protection Authority (EPA).

The NSW Government applies a whole-of-government approach to managing air quality, working with other jurisdictions, NSW agencies and also with industry, local government and community stakeholders. The NSW Government also actively monitors air quality research and management practices from overseas and in other Australian jurisdictions, to keep abreast of emerging issues and develop appropriate responses tailored to NSW's needs.

The NSW Government is committed to:

- building knowledge and communicating information transparently and effectively to support actions that protect air quality and public health
- developing innovative policy, and regulatory and economic tools to accelerate the reduction of air emissions, including the adoption of cleaner technologies and improved operating practices
- effective implementation, enforcement and evaluation to ensure the benefits of clean air policies and programs are fully realised.

The current body of evidence that underpins air quality management in New South Wales and the actions in this Strategy is summarised in the Appendix.

Air quality management in New South Wales is guided by national health-based standards for priority pollutants set under the National Environment Protection (Ambient Air Quality) Measure (the Air NEPM). Pollutants monitored under the Air NEPM standards include:

- particles less than 10 micrometres in diameter (termed PM<sub>10</sub>)
- fine particles less than 2.5 micrometres in diameter (PM<sub>2.5</sub>) – these are a subset of PM<sub>10</sub>
- ozone (O<sub>3</sub>) – a secondary pollutant, formed when nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs) react in the air on hot, sunny days
- nitrogen dioxide (NO<sub>2</sub>)
- sulfur dioxide (SO<sub>2</sub>).

National standards for PM<sub>2.5</sub> and PM<sub>10</sub> were strengthened in 2016 and more stringent standards for ozone, nitrogen dioxide and sulfur dioxide were adopted in May 2021. The upgrading of standards reflects new evidence of the impacts and costs of air pollution to Australian communities.

Air quality is monitored against the Air NEPM standards to evaluate health risks in regions across New South Wales and keep decision-makers and communities informed. New South Wales has the most comprehensive air quality monitoring network in Australia with more than 90 stations, and we continue to expand and enhance the network (see Figure 1).

The NSW Government also collaborates with the Commonwealth, and other states and territories, through the National Environment Protection Council and National Air Technical Advisory Group, on projects under the *National Clean Air Agreement* to strengthen standards and improve air quality. Standards for emissions from new vehicles, shipping, small engines and fuel quality are also set under national legislation. The NSW Government advocates strongly for clean air standards and measures in national forums.

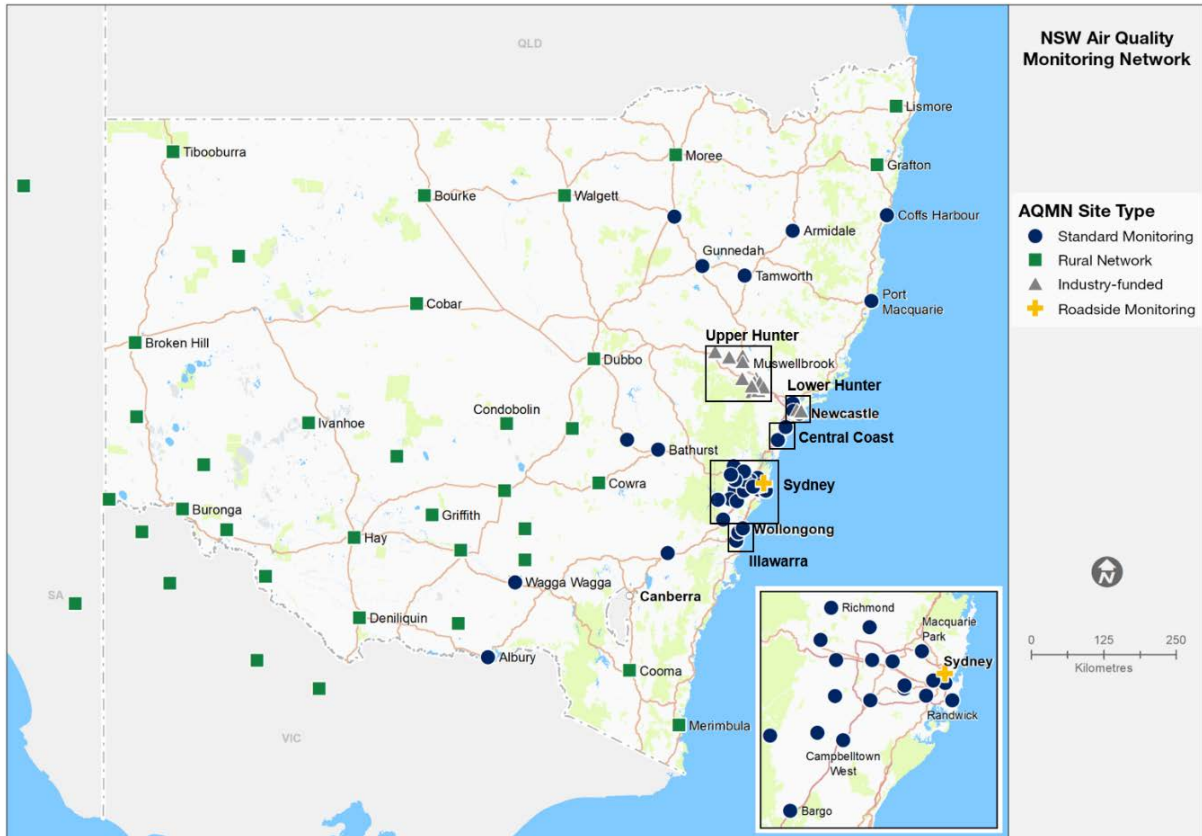


Figure 1 NSW air quality monitoring network

The primary NSW legislation that supports clean air actions by the NSW Government, councils, businesses and individuals is the *Protection of the Environment Operations Act 1997* (POEO Act), administered by the EPA. It sets the statutory framework for managing air quality in New South Wales and requires environment protection licences for industrial activities regulated under the Act.

Under the POEO Act, the Protection of the Environment Operations (Clean Air) Regulation 2021 (POEO Clean Air Regulation) sets out measures to control emissions from industry, motor vehicles and fuels, domestic solid fuel heaters and open burning. The POEO (General) Regulation 2021 establishes the licensing scheme for major industrial premises, including load-based licensing provisions that provide economic incentives for certain industry facilities to reduce pollution, including emissions to air.

Other NSW legislation and instruments important to improving air quality relate to planning, transport and energy. Planning and designing sustainable and liveable cities, regions and neighbourhoods, and delivering electric vehicles and improved freight, public transport and active transport connections can all support cleaner air. The *NSW Electricity Strategy*, *Electricity Infrastructure Roadmap* and *Net Zero Plan* will deliver major gains for air quality and health by supporting transitions to cleaner energy, industry, transport and households.



The NSW Government has a strong agenda to support NSW regional communities and economies. In a clean air context, this involves enhancing the air quality monitoring network. Key elements include strengthening capacity to deploy emergency monitors during extreme events, and improving the timeliness, usefulness and accessibility of health advice for affected communities.

The *Net Zero Plan*, *NSW Electricity Strategy*, *Electricity Infrastructure Roadmap*, *Hydrogen Strategy* and *NSW Electric Vehicle Strategy* will help deliver air quality benefits for NSW regions, through reduced emissions from power generation, transport, industry and agriculture, as well as economic and social benefits for local business and communities. Development of new growth and employment areas, including Special Activation Precincts, will also provide opportunities to deliver new and cleaner industry to support healthier communities and economies.

At the local level, councils have a key role in managing air quality, including through regulatory responsibilities for activities such as managing emissions from wood heaters. Councils also manage air pollution and its impacts on communities through local land-use and transport planning. The NSW Government supports councils by providing management frameworks, tools, guidance and resources for local clean air initiatives. The NSW Government also leads by example, with environmental requirements mandated for its agencies under the *NSW Government Resource Efficiency Policy*, which can also provide a model for local councils, businesses and the community.



Singleton Monitoring Station. Photo: Jason Potts/DPE



## Effects of air quality on health

High levels of air pollution can cause severe acute health conditions, and even low levels of pollution that meet air quality standards can harm people if they are exposed over the long term. Vulnerable people, including the elderly, children and those with chronic health conditions are generally the most affected.

Factors that contribute to health risk and accordingly guide our priorities for air quality management include:

- the types of pollutant to which people are exposed, the level and duration of exposure and, following from these, the degree of harm they cause
- the regions and locations experiencing cumulative impacts and higher concentrations of harmful pollutants
- the areas where population exposure to local and regional pollution is higher or increasing as a result of high or increasing population densities.

Fine particles (PM<sub>2.5</sub>) have the largest health impacts across New South Wales. Actions in this strategy reflect our understanding that the greatest public health benefits will come from sustained reductions in long-term exposure of large populations to fine particles.

Continued action to reduce exposure to air pollution will help avoid adverse symptoms, the need for medication, visits to doctors and emergency departments, hospital admissions and premature deaths across cities and regions. Actions that achieve even small improvements in air quality can result in significant public health benefits. Further information on the impacts of air quality on health is included in the Appendix.



Newcastle Memorial Walk. Photo: John Spencer/EPA



## Actions to improve outcomes for air quality and health

The NSW Clean Air Strategy 2021–2030 aims to achieve ongoing reductions in the impacts of air pollution on the people of New South Wales, while supporting liveable communities, healthy environments and the NSW economy.

The NSW Government will implement actions to achieve further health gains for communities across New South Wales under the five themes of better preparedness for pollution events, cleaner industry, cleaner transport, healthier households and better places. The actions under each theme are presented in summary, followed by more detailed discussion of key aspects, including responsibility and timing for actions.

### 1. Better preparedness for pollution events

#### Proposed Government actions

##### Enhance the NSW air quality monitoring network and data

- Improve the NSW air quality monitoring network to increase knowledge of air quality experienced across New South Wales.
- Improve evidence on air pollution and its impacts on local communities, including in NSW regions and hotspots (e.g. by increasing roadside monitoring).

##### Improve how we manage and communicate air pollution and health information

- Collaborate through the national Environmental Health Standing Committee (enHealth) and National Air Technical Advisory Group to ensure adoption of a nationally consistent and effective approach for reporting air quality and health information.

##### Improve air quality nowcasting and forecasting

- Increase real-time information ('nowcasting') available for people to manage their exposure to harmful levels of air pollution.
- Improve forecasting for Sydney and progressively expand forecasting to the whole of the NSW Greater Metropolitan Region and major regional areas.

##### Build the health impacts evidence base that underpins air quality management

- Collaborate with experts and other jurisdictions to research and deliver evidence-based responses to emerging issues (e.g. our understanding of ultrafine particles under 1 micrometre in diameter) and update evidence of the economic and health costs of air pollution to New South Wales.

##### Support community monitoring and understanding of air quality data

- Collaborate through the National Air Technical Advisory Group to provide guidance on the use of low-cost sensor technologies to measure air pollution impacting on communities.

##### Improve understanding and management of the health impacts of smoke from bushfires and hazard reduction burns

- Engage with ongoing research into the health impacts of smoke from landscape fires (including immediate and long-term impacts) on vulnerable groups and the broader population.
- Enhance management of the smoke impacts of hazard reduction burns through improved planning, assessment and communication.

## Information and advice that supports sound decision-making

The department operates the largest and longest running air quality monitoring network in Australia with more than 90 monitoring stations. The network monitors and reports air quality against national standards and provides reliable, timely air quality information to the people of New South Wales. This is the basis for sound decision-making on air quality management, ranging from government strategies to advice by agencies and day-to-day decisions by communities and individuals on how they can reduce their exposure and best protect their health from air pollution.

In recent years, the department has established new monitoring stations in the Sydney, Parramatta and Penrith central business districts (CBDs); added new regional monitoring capacity at Armidale, Gunnedah, Morisset, Narrabri and Orange; and expanded the monitoring at other existing regional sites. It has also significantly expanded and upgraded the Rural Air Quality Monitoring Network and commenced roadside monitoring.

The department enhanced its air quality monitoring capability in 2014 by establishing an emergency incident response system. This ensures air pollution measurements and reporting can be established at major incidents and events anywhere in the State within 24 hours.

The NSW air quality monitoring network will continue to be improved based on the needs of the NSW community. This is reflected in the updated *NSW Air Quality Monitoring Plan 2021–25*, which is subject to regular review.

Air quality data from the monitoring network is provided on a dedicated government webpage, allowing the community, industry and government to access accurate and up-to-date air quality information. Improvements are delivered through the Enhanced Website and Data Delivery project, which is designed to ensure that all NSW Government data and information on air quality is freely available, and is easily and intuitively accessible by the community, researchers and decision-makers.



Regional dust monitoring site on Kulkurna Station, Lake Victoria. Photo: Belinda Hansen

The department will work towards improving the accuracy of forecasting for Sydney and will progressively expand forecasting to the whole of the NSW Greater Metropolitan Region and major regional areas. This will be supported by comprehensive statewide alerts and air quality forecasting systems. Air quality alerts are issued in near real-time when actual air pollution at a monitoring station exceeds the relevant standards. Daily air quality forecasting is currently available for Sydney for the following day. The forecast takes multiple factors into account, including human-made emissions, existing bushfires, planned hazard reduction burns and dust movement.

Air quality monitoring is combined with programs to map and forecast air pollution, estimate emissions and characterise the impacts of air pollution. The department works closely with other agencies, universities and jurisdictions, such as the Australian Nuclear Science and Technology Organisation and CSIRO, to understand and predict air pollution and its health impacts on the community, and enhance the information and knowledge evidence base for managing air quality.

As air quality sensor technology improves and sensors become more affordable and available, community and academia are also installing their own low-cost monitoring systems and publishing their results. The NSW Government and other jurisdictions are collaborating through the National Air Technical Advisory Group to develop consistent guidance on the use of sensors, to support stakeholders in understanding and using this new data source.

The department is also working across government via the NSW Spatial Digital Twin and Digital Strategy to provide seamless air quality information from low-cost sensing networks. The NSW Spatial Digital Twin is creating a digital model of our cities and communities that will facilitate better planning, design and modelling for New South Wales's future needs. NSW Government air quality datasets are also available via the Sharing and Enabling Environmental Data portal (SEED), which is the State's central resource for environmental data.

### **Blue Mountains and Lithgow community monitoring project**

The Blue Mountains and Lithgow Air Watch project was established in response to ongoing community concerns about air quality in the Blue Mountains and its impacts on public health. An EPA chaired steering committee, with representatives from the department, community and environmental groups, local councils and Western Sydney University, guided the 12-month project, which commenced in May 2019.

The project consisted of an air quality monitoring station at Katoomba and 12 low-cost air quality sensors, known as 'KOALAs' (Knowing Our Ambient Local Air-Quality) located at local schools and businesses in Wentworth Falls, Springwood, Katoomba and Lithgow.

The community and committee engaged in the project by:

- deciding on monitoring locations
- liaising with volunteers to host and look after the KOALAs
- sharing information and findings from the project with the broader community.

The final report released in November 2020 found that the region generally enjoys very good air quality. The most significant impacts on local air quality during the study period were the unprecedented 2019–20 bushfires and major dust storms. Further information is available on the *Blue Mountains and Lithgow Air Watch* webpage.

## Landscape fires and other extreme events

During pollution events such as bushfires, NSW agencies work closely together to protect, and provide information to, the community. Air quality monitoring and forecasting information from the department together with advice on the health effects of air pollution from NSW Health are provided to government and the public. During fire events, the NSW Rural Fire Service (RFS) also provides information and smoke advisories on its [Fires Near Me](#) website and app.

The department is also developing and deploying an advanced air quality modelling system. The new modelling system simulates ozone, particulate matter, toxic airborne pollutants, visibility, and acidic and nutrient pollutant species throughout the troposphere using the latest scientific knowledge gathered from around the globe. This new modelling approach will minimise modelling inconsistencies and provide more objective evaluation.

Similar to weather forecasts, the community expects accurate air quality information to make informed decisions about action they should take in the event of elevated or extreme pollution. Public advice is focused on equipping people to take reasonable measures to reduce their pollution exposure. It also provides targeted information to vulnerable groups who may, for example, need to avoid outdoor exercise or apply asthma plans at times.

### Hazard reduction burn smoke management

Hazard reduction is an important part of preparing for bushfires. The NSW Government is committed to carrying out hazard reduction burning, while balancing the potential impacts of smoke on the community.

An interagency committee considers ways to better manage smoke impacts on human health and the environment from hazard reduction burns. The steering committee developed the communication and smoke management protocols to ensure agencies coordinate management and communication of risks to human health and the environment during landscape fires.

Experts with air quality forecasting capabilities in the department, the Australian Bureau of Meteorology and the RFS assess the potential for smoke impacts before hazard reduction burns are done. The results of the assessment may trigger activation of the communication and smoke management protocols and actions to minimise smoke impacts.

Information on the committee and the protocols is available on the RFS *Managing smoke and its impact on the community* webpage.

During extreme air pollution events, the emergency incident response system for air quality monitoring can be deployed at short notice. The 2019–20 bushfire season saw full deployment and enhancement of the department's emergency monitoring capabilities and upgrades to the NSW Government air quality website (see Figure 2). This provided accessible and easy to understand information on air pollution for stakeholder groups and the general public.

The NSW Government is working with other jurisdictions, through the National Air Technical Advisory Group and enHealth, to develop nationally consistent health information that is more easily understood by the community, for dissemination during smoke events. New hourly reporting categories are now published, and health alerts have been revised. The NSW Government will conduct and publish a review on the communication of air quality information and health alerts to the public to ensure its effectiveness.

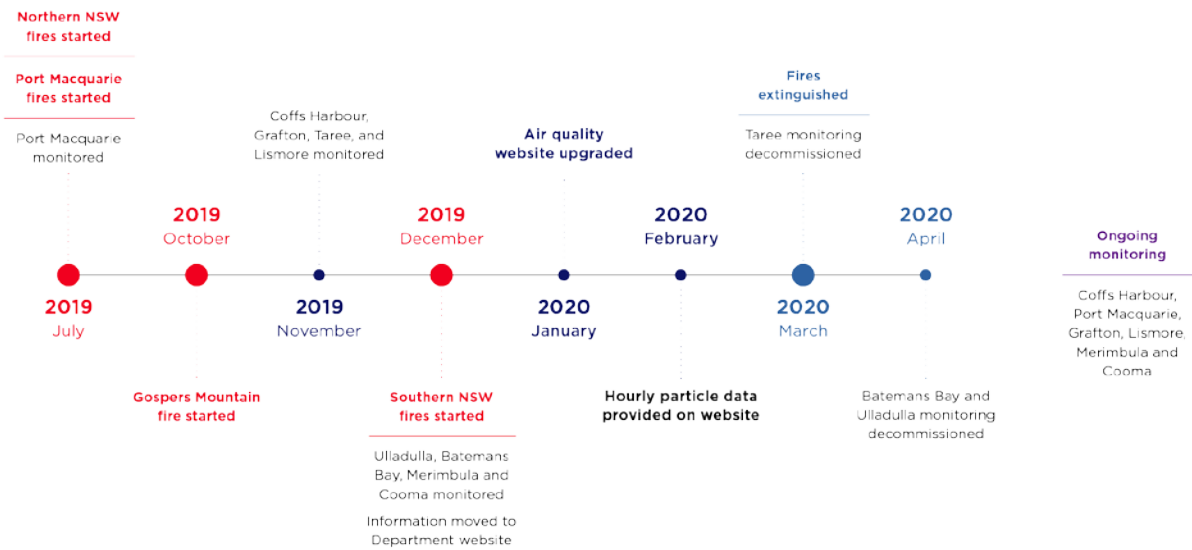


Figure 2 Expansion and upgrading of air quality monitoring and communication during the ‘Black Summer’ fires of 2019–20

## Bushfire research

The NSW Bushfire Risk Management Research Hub brings together researchers, fire agencies, public land managers and Indigenous knowledge holders in a collaborative research effort that will improve our understanding of bushfire behaviour and risk. One of the key research areas is understanding cultural burning in New South Wales and the linkages to community resilience and wellbeing.

Research projects have also been undertaken through collaborations with universities and other jurisdictions to understand current and future health impacts from air pollution and to continuously improve air quality monitoring and forecasting capabilities. The NSW Government supports research through the Centre for Air pollution, energy and health Research (CAR) to investigate the health effects of bushfire smoke in New South Wales.

The Commonwealth Medical Research Fund has provided \$5 million to projects to investigate bushfire impacts on vulnerable groups and first responders, as well as long-term health impacts.

## 2. Cleaner industry

### Proposed Government actions

#### Strengthen the clean air regulatory framework

- Explore opportunities to further modernise and improve the regulatory framework, with the objective of continuously improving the management of air pollution in New South Wales and ensuring industry (licensed and unlicensed) minimises emissions using reasonable and practical measures, while enabling innovation.
- Ensure continuous improvement in environmental performance through the statutory remake of the POEO Clean Air Regulation, by reducing pollution from older plant and equipment and from storage of volatile organic liquids.
- Finalise review of the load-based licensing scheme to ensure the scheme is well targeted, efficient and effective at encouraging further emissions reductions where they are most needed.
- Modernise air assessments for industry development proposals, by updating Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales and Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales.

#### Support a reliable, affordable and sustainable electricity future

- Support private sector investment in new clean energy generation, under the NSW Electricity Infrastructure Roadmap, to replace ageing fossil fuel-powered generators as they retire in coming decades.
- Ensure potential air quality impacts are properly considered in the planning and regulation of all new energy projects.

#### Support industry to lower their emissions through the Net Zero Industry and Innovation Program and NSW Hydrogen Strategy

- Implement the \$750 million NSW Net Zero Industry and Innovation Program, which will help high-emitting industrial facilities reduce emissions, support creation of decarbonised supply chains and focus on cleaner technologies.
- Implement the NSW Hydrogen Strategy, which provides an estimated \$3 billion of incentives to support the commercialisation of the emerging hydrogen industry and enables industry to increase uptake of hydrogen as an alternative fuel and feedstock.

#### Continue to better manage the impacts of mining

- Support the improved management of air impacts from coal mining, as required under the *Strategic Statement on Coal Exploration and Mining in NSW*. Through the department and the EPA, work with the coal mining and extraction industries to further reduce dust emissions and maintain strong compliance campaigns. Continue to research, develop and trial innovative compliance assurance tools and emission reduction programs.

#### Support the energy from waste policy

- Implement the strict air emissions standards in the *NSW Energy from Waste Policy Statement* that are based on the advice from the Office of the NSW Chief Scientist and Engineer.
- Implement the strategic planning actions in the *NSW Energy from Waste Infrastructure Plan*, which supports the *NSW Waste and Sustainable Materials Strategy*, to ensure energy from waste infrastructure is located in areas where it maximises benefits for waste management and innovation, economic growth, the protection of air quality and human health into the future.



### Improve the guidance and information available for councils to manage air pollution

- Update the NSW *Local Government Air Quality Toolkit* and support councils in applying it to ensure local pollution sources are managed effectively.

## Strengthening industry regulation and compliance

Activities such as mining, power generation, construction, manufacturing, waste management and agriculture can have direct air quality impacts in local areas and wider impacts across regions. The NSW Government will continue to provide efficient, effective and innovative industry regulation, and implement policies and programs that protect communities from adverse health impacts of industry emissions, while delivering net social and economic benefits.

As the primary environmental regulator for New South Wales, the EPA works with business, government and the community to reduce pollution and risks to human health and protect the environment. The EPA applies best practice regulation to ensure industry (licensed and unlicensed) minimises emissions using reasonable and practical measures, while enabling innovation.

The EPA holds individuals and organisations to account through a range of regulatory approaches (including licensing, compliance, enforcement, monitoring, reporting and publication requirements), supported by education, economic incentives and pollution reduction studies and programs. The EPA will look for opportunities to further modernise and improve its regulatory framework, with the objective of continuously improving the management of air pollution in New South Wales.

A key regulatory mechanism in New South Wales for reducing harmful air emissions is the POEO Clean Air Regulation. It regulates the emission of pollutants from industry, as well as from motor vehicles and motor vehicle fuels, wood heaters and backyard burning.

The POEO Clean Air Regulation is periodically reviewed so it remains relevant and effective. Each review takes account of the latest environmental and health research and current technologies, environmental practice and emission standards. Preliminary analysis for the next review has identified potential actions to improve industry performance with net benefits of around \$600 million over 20 years.

The EPA's load-based licensing (LBL) scheme embeds the 'polluter pays' principle into the EPA's regulatory framework and encourages cleaner production. LBL requires some of the EPA's licensees to pay additional fees based on the load (total mass in kilograms) of air and water pollutants their activities release to the environment; the more they pollute the more they pay. The scheme provides an incentive for licensees to reduce their emissions and improve their environmental performance beyond what is required by their licence conditions or regulations alone, for example, to install planned plant improvements earlier.

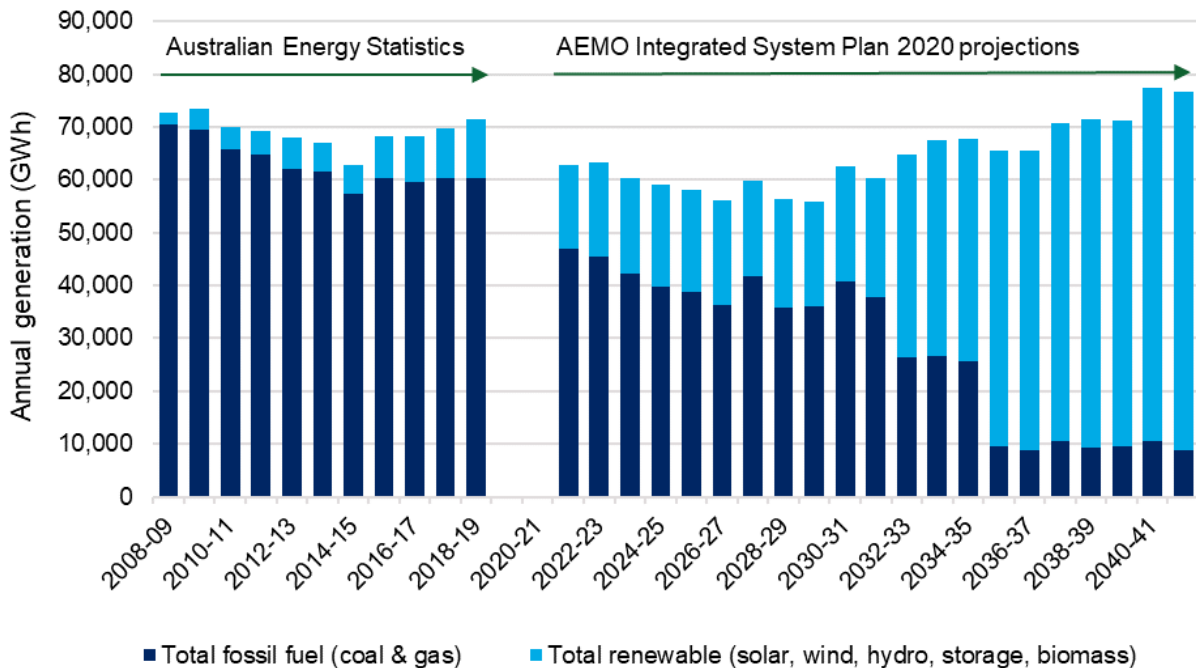
The EPA is currently reviewing the LBL scheme to ensure it is well-targeted, efficient and effective at encouraging further emissions reductions where they are most needed. The EPA conducted public consultation via an issues paper in 2016 and will consult the public on any specific changes proposed to the LBL scheme. For more information see the *Review of the load-based licensing scheme* webpage.

The EPA will review the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales to ensure industry air assessments are based on contemporary standards and practices. The NSW Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales will also be reviewed to ensure that industry measures air emissions using contemporary standards and practices.

## Clean energy for clean air

New South Wales is moving towards cleaner energy and implementing cleaner technology programs. Under a bilateral Memorandum of Understanding on Energy and Emissions between New South Wales and the Commonwealth, \$2 billion will be committed over 10 years to energy efficiency, electric vehicle infrastructure and model availability, coal innovation, primary industries productivity and abatement, clean technology and hydrogen programs.

The NSW electricity system is transforming, with a large number of decentralised generators like wind, solar farms and other technology types connecting, while older coal fired electricity generators are retiring (Figure 3). This will deliver substantial emission reductions and air quality improvements across New South Wales.



**Figure 3** Projected change in NSW electricity generation mix (gigawatt hours) as per 2020 Integrated System Plan

Source: Australian Energy Market Operator

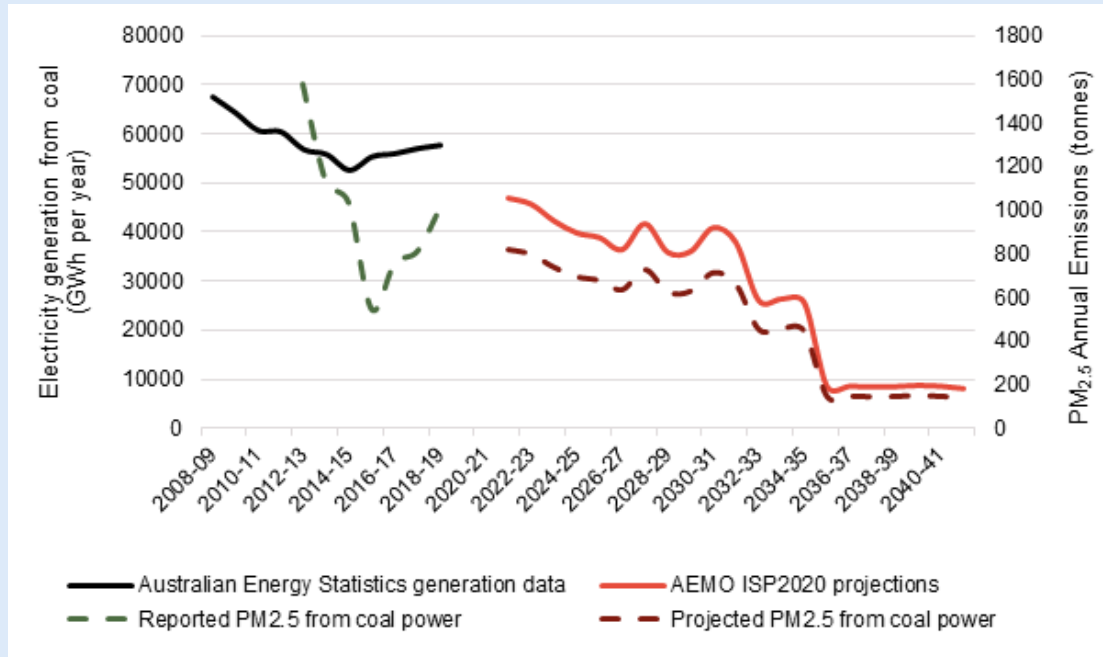
Five NSW Renewable Energy Zones will be supported by an Electricity Infrastructure Investment Safeguard to facilitate private investment in new renewable energy generation, long duration storage and firming projects. Increased reliance on pumped hydro power, batteries and hydrogen energy storage will also contribute to energy security and improving air quality.

The Australian Energy Market Operator’s (AEMO) *Integrated System Plan* notes that the least-cost and least-regret transformation of the electricity system is from a centralised coal fired generation system to a diverse portfolio of renewable energy supported by firming and enhanced grid and service capabilities. Modelling from the *Integrated System Plan* has confirmed the necessary replacement generation in New South Wales is likely to be a mix of wind, solar, gas and storage.

The replacement of large-scale coal fired power stations with smaller and geographically dispersed renewable generators involves significant investments in new transmission and other infrastructure to maintain electricity security and reliability. Many of these investments have long lead times and require complex integration with the rest of the power system. As a result, an orderly approach to the retirement of the State’s coal fired power stations is important to ensure security and reliability of electricity supply and avoid adverse impacts on prices.

## The NSW Electricity Infrastructure Roadmap

The *NSW Electricity Infrastructure Roadmap* supports this *Clean Air Strategy* by facilitating the entry of new renewable energy generation to replace existing ageing coal fired power stations as they close over the coming decades. The transition from ageing coal fired power stations under the *Electricity Infrastructure Roadmap* will deliver significant health benefits through the reduction of fine particle emissions by an estimated 80% by 2041 (Figure 4).



**Figure 4** Past and projected reduction in PM<sub>2.5</sub> emissions (tonnes/year) and electricity generated from coal (gigawatt hours/year) based on 2020 Integrated System Plan

Currently five coal fired power stations operate in New South Wales: Bayswater, Liddell, Mount Piper, Vales Point and Eraring. Operators of these power stations are required to control and minimise air pollutant emissions under the POEO Act, the POEO Clean Air Regulation and their environment protection licences. All operators must continuously monitor nitrogen oxides and sulfur dioxide and use best practice techniques to filter particle pollution.

The EPA issued variations to the licences of all five NSW coal fired power stations in July 2020 and continues to work with operators to further strengthen licence conditions, ensure greater consistency between licences and ensure licensed emission limits are consistent with operational performance. Licences are subject to review every five years.

## Reducing mining impacts

Use of thermal coal will decline over the coming decades as our coal-fired electricity plants reach the end of their technical lives and are replaced with cleaner forms of energy generation. To support the transition, the NSW Government is building economically resilient regional communities that can take advantage of new economic opportunities.

The *Strategic Statement on Coal Exploration and Mining in NSW* outlines the NSW Government’s intentions for coal mining. This includes supporting improved management of air impacts from coal mining. Areas being considered for release for new coal exploration titles are subject to an up-front assessment of environmental, social and economic factors, including consideration of air quality impacts.

Coal mining activities in New South Wales are managed through development assessment, regulation and compliance programs.

All mining applications must be accompanied by a detailed air quality assessment. This assessment will be carefully considered by relevant Government agencies including the department and the EPA as part of the development assessment process.

If approved by the planning consent authority, mines must comply with the conditions of consent and any conditions on an environment protection licence. Together these conditions set out air quality criteria and operating conditions that must be met, including the need to implement best practice management to minimise any air quality impacts.

The NSW Government has compliance and enforcement processes in place to ensure these conditions are met. The department is responsible for regulating compliance with the conditions of consent under the *Environmental Planning and Assessment Act 1979* and the EPA is responsible for regulating compliance with the environment protection licence under the POEO Act.

Both the EPA and the department frequently inspect mines to ensure they are meeting the conditions and requirements, including that extra precautions are in place on days when there is a higher risk of dust.

The NSW Resources Regulator is responsible for regulating rehabilitation of mines under the *Mining Act 1992* and ensuring the conditions of mining leases are met. This includes making sure rehabilitation is carried out progressively, that is, as soon as reasonably practicable following disturbance, and that exploration and mining-affected land is left in a safe and stable condition. Effective rehabilitation of mining sites is an important component of managing dust impacts on regional communities.

### Coal mine dust management

The EPA and the department undertake periodic campaigns to ensure dust is managed at coal mines.

In 2018 the EPA undertook a special operation targeting Hunter region coal mines to tackle excessive dust levels. Operation Dust Patrol involved frequent inspections of mines on hot, dry and windy days to check extra controls were in place at the mines to minimise dust. This operation found most mines were compliant with EPA requirements. Despite the dry conditions in that period, mine dust emissions were at their lowest since monitoring began in 2012.

Throughout the spring periods of 2019 and 2020, the EPA's Bust the Dust compliance campaign in the Hunter region included the use of drones to help EPA officers better identify the source of dust plumes and observe impacts on air quality. This campaign was supported by officers from the department.



Coal mine dust compliance check with drone. Photo: Gina Bradley

## Reducing emissions from industry and agriculture

Many large and small businesses in New South Wales rely on plant and processes that are energy intensive and generate high carbon emissions per unit of production, at the same time producing emissions that impact air quality. This extends from cement, steel and aluminium manufacturing processes to factories and farms that use fossil fuels to power onsite plant and equipment.

A number of initiatives in the *Net Zero Plan* are targeting emission reductions from industry and agriculture including the NSW Net Zero Industry and Innovation Program (NZIIP) and the Primary Industries Productivity and Abatement Program (PIPAP).

The NZIIP is a \$750 million program that will help NSW industries reduce their emissions. The program has three focus areas: clean technology innovation; reducing the emissions of high emitting industries; and working with industry to deliver infrastructure that will enable new low emissions production. The program will contribute at least \$70 million to support the establishment of hydrogen hubs in the Hunter and Illawarra.

The PIPAP will support primary producers and landowners to commercialise low emissions technologies and to access revenue from carbon markets. The program will also support the development of premium land-based carbon markets that deliver carbon abatement alongside environmental, economic and social outcomes.

These programs will be complemented by the Commonwealth's \$450 million commitment to New South Wales from the Climate Solutions Fund. The Climate Solutions Fund supports Australian businesses, farms and land managers to take practical, low-cost actions to reduce carbon emissions.



Industry in Newcastle. Photo: John Spencer/DPE

Under the *NSW Hydrogen Strategy*, the NSW Government is committing to a range of initiatives to support the commercialisation of hydrogen technologies in New South Wales. Hydrogen that is produced from sustainable resources and using renewable energy has potential to provide a fuel with net zero carbon and air pollution emissions (CSE 2020). Low renewable energy costs will make Australia one of the most cost-competitive locations to produce hydrogen.

As well as a prospective new industry, the hydrogen initiative is expected to deliver large air quality benefits for New South Wales. Hydrogen has the potential to fuel industrial processes that cannot be electrified and provide a pathway to eliminate the nitrogen oxides, sulfur oxides and particulate pollution associated with industrial burning of fossil fuels. Hydrogen can also be used as a transport fuel and is particularly competitive in the heavy transport sector, replacing diesel use and reducing carbon emissions and air pollutants.

## NSW Hydrogen Strategy

The NSW Hydrogen Strategy is our policy framework to support the development of a commercial hydrogen industry in NSW. The Strategy has stretch targets for 2030, including 110,000 tonnes of green hydrogen being produced per annum in NSW and 10,000 hydrogen vehicles on our roads. The Strategy includes a range of measures to support industry development, including \$3 billion of incentives to support commercialisation of hydrogen supply chains. Through the Strategy, we will support industry to adopt green hydrogen, develop hydrogen hubs at our major ports, build a hydrogen refuelling network for heavy vehicles along major highways, create a market led framework to drive demand for green hydrogen and waive a wide range of taxes and charges to dramatically reduce the cost of green hydrogen. Clean hydrogen’s potential as an industrial, stationary energy and transport fuel provides a pathway to replace eliminate harmful nitrogen oxides and particulate pollution from burning fossil fuels and improve air quality.

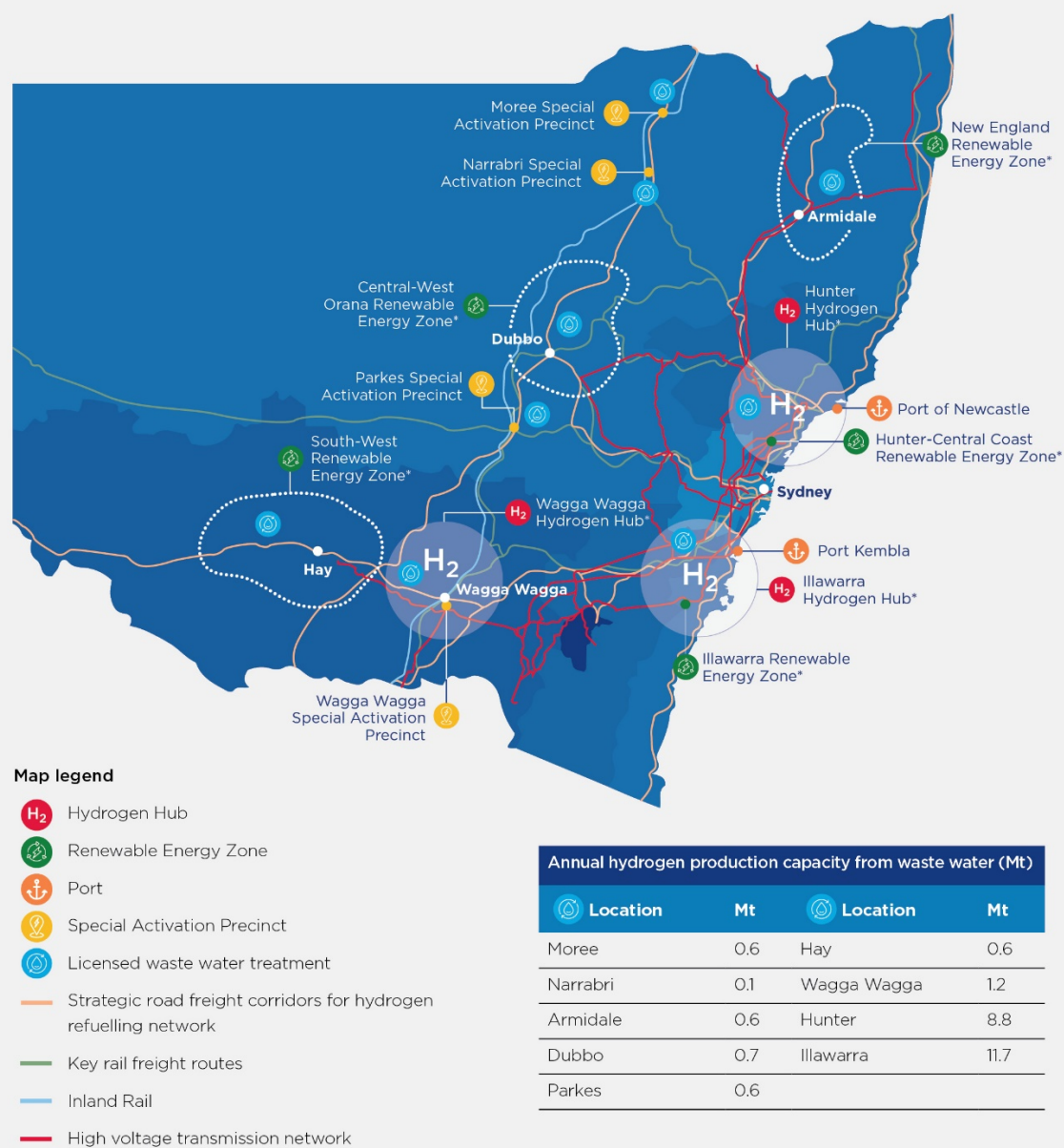


Figure 5 Integrated NSW Hydrogen Economy

## Regulating energy from waste

The *Waste and Sustainable Materials Strategy 2041* sets out a blueprint for how New South Wales deals with waste into the future. As part of an integrated waste management strategy, energy from waste projects can provide an alternative to landfill for residual waste where further material recovery through reuse, reprocessing or recycling is not achievable.

The NSW Government is taking a strategic approach to the role of energy from waste infrastructure to ensure such projects protect the environment and human health into the future, and maximise efficiencies for waste innovation, management and energy recovery. In September 2021, the NSW Government released the *NSW Energy from Waste Infrastructure Plan 2041*, which outlines the strategic planning considerations for future energy from waste infrastructure. The Plan ensures waste infrastructure is in precincts most suitable for managing the State's residual waste, providing innovation and investment opportunities, and protecting air quality for communities.

The Plan provides certainty and transparency to industry and the community on where energy from waste can be established and operated to manage genuine residual waste. It restricts new infrastructure to four priority infrastructure areas:

- West Lithgow Precinct
- Parkes Special Activation Precinct
- Richmond Valley Regional Jobs Precinct
- Southern Goulburn Mulwaree Precinct.

Outside these areas, energy from waste will only be permitted if the facilities use waste, or waste-derived feedstock, to replace less environmentally sound fuels (including coal or petroleum-based fuels) to generate energy at the site, and where that energy is used to power industrial and manufacturing processes on site.

Energy from waste proposals must continue to comply with environmental and planning laws, including the *NSW Energy from Waste Policy Statement*.

The *NSW Energy from Waste Policy Statement* was updated in June 2021 to reflect the latest scientific advice on air emission standards from the NSW Chief Scientist and Engineer, and ensures New South Wales has the strictest air quality standards in the world for energy from waste.

## Supporting local government

The EPA works with local councils to help reduce emissions and improve air quality in their areas. This includes supporting them in their role in planning and as regulators for local industrial, commercial and domestic air emission sources and in developing and implementing measures to reduce air pollution in their areas.

The EPA developed the *Local Government Air Quality Toolkit* to bring together the resources necessary to help council officers perform their air quality management functions. The toolkit presents the sources and impacts of air pollution, the regulatory framework for protecting air quality in New South Wales, air quality management procedures and technologies, and guidance for managing air polluting activities identified as priorities by councils.

The department and the EPA will update and expand the toolkit to reflect changes in councils' roles, the challenges they manage and the approaches available to them to improve air quality for their own communities and more widely.



### 3. Cleaner transport, engines and fuels

#### Proposed Government actions

##### Integrate air quality improvements into transport planning, programs and projects

- Integrate air quality into strategic decision-making, including the development, implementation and review of strategies such as *Future Transport 2056*, the *State Infrastructure Strategy* and the plans, programs and projects that sit under these, to improve air and health outcomes across urban and regional New South Wales.

##### Progress policies and incentives to increase uptake of zero and low exhaust emission vehicles

- Support New South Wales’s transition to electric and cleaner vehicles, including by providing incentives for electric vehicle uptake, support for charging infrastructure and improved consumer information.
- Trial and scale up the use of hydrogen fuel cell technology as a potential alternative to diesel power in heavy vehicles.
- Expand rollout of zero emission buses into the NSW fleet.

##### Implement the NSW Hydrogen Strategy, including support for deployment of hydrogen refuelling stations and vehicles through our hydrogen hub and refuelling network initiatives. Support sustainable, healthy and smart travel choices

- Embed travel demand management principles and the Travel Choices behaviour program in the delivery of NSW transport projects to support uptake of sustainable transport. Deliver the Travel Choices program for employment, health and education precincts in collaboration with councils, employers and relevant agencies.
- Support flexible, efficient and sustainable travel through mobility-as-a-service (MaaS) initiatives.
- Promote walking and cycling as zero emission everyday transport through investment in walking and cycling programs and infrastructure.

##### Improve regulation of vehicle and fuel emissions

- Advocate at the national level for cleaner vehicle emissions and fuel quality standards, harmonising with the latest European standards.
- Remake the POEO Clean Air Regulation to strengthen provisions for reducing petrol volatility during hot weather and for storage of volatile organic liquids such as fuels, to reduce ozone-forming emissions.
- Update the NSW *Local Government Air Quality Toolkit* to improve support to councils in regulating vapour recovery at service stations.

##### Drive emission reductions from non-road diesel vehicles and equipment

- Co-lead the project under the *National Clean Air Agreement* to assess the costs and benefits of introducing Australian emissions standards for non-road diesel equipment.
- Complete research into the health impacts of the NSW non-road diesel sector.
- Promote adoption of modern clean technologies in priority non-road diesel sectors.
- Ensure the NSW Government leads by example in the use of clean non-road equipment through procurement requirements on government agencies in the NSW *Government Resource Efficiency Policy*.

## Clean future transport

Actions to address transport emissions are included under the NSW Government’s transport plan, *Future Transport 2056* and related plans. Strategies to increase the efficiency of freight movements, manage peak hour demand on the network, increase accessibility and reduce overall travel demand, support transition to zero exhaust emission vehicles, and provide public and active transport options for growing communities all contribute to cleaner air.

### NSW Electric Vehicle Strategy

The *NSW Net Zero Plan* and *NSW Electric Vehicle Strategy* include significant actions to promote uptake of electric vehicles. As well as reducing greenhouse gas emissions, actions under the Electric Vehicle Strategy will reduce vehicle exhaust emissions leading to improved air quality and health benefits.

The NSW Government will reduce the upfront cost of electric vehicles through rebates and changes to stamp duty and will co-invest with the private sector in a network of ultra-fast chargers. Incentives for purchasing electric vehicles will be offered to owners of medium to large sized fleets such as local councils, businesses and car rental and car share companies. The NSW Government will also support changes to standards for new buildings to make it easy to install electric vehicle charge points.



Electric vehicle and app showing its battery charge. Photo: Quentin Jones/DPE

### *Zero Emission Bus Transition Strategy*

The NSW Government is committed to taking advantage of new technology that reduces the impact current diesel buses have on air quality and people’s health.

Transport for NSW has developed a *Zero Emission Bus Transition Strategy* to help reduce transport-based air and greenhouse gas emissions and support the goal of net zero emissions by 2050. The strategy considers the strategic pathway for transition to electric buses, opportunities to use electric and hydrogen fuel cell technology and the energy requirements to support transition, as well as infrastructure, customer and financial implications.

Transport NSW has begun rolling out zero exhaust emission electric buses into the NSW bus fleet and to date a total of 89 battery electric buses have been ordered to arrive by mid-2022, with 22 of these now in passenger service across Greater Sydney.



One of New South Wales’s new electric buses. Photo: Transit Systems

### **Hydrogen hub and refuelling network initiatives**

Under the *NSW Hydrogen Strategy*, we are delivering our \$70 million hydrogen hub initiative, which aims to support the deployment of hydrogen vehicles and refuelling stations as part of hydrogen hubs in the Illawarra and Hunter regions. We will also provide financial support to industry to deliver an integrated refuelling network that can supply hydrogen fuel along the major logistics corridors connecting the east coast states. This foundational infrastructure and initial vehicle deployment will demonstrate technology and commercial models to enable rapid uptake of hydrogen vehicles in sectors where battery electrification is not feasible. (See also Figure 6 above).

## Healthy transport

The NSW Government is committed to encouraging people to walk or ride a bike as part of their everyday travel. As well as being zero emission transport, walking and cycling for commuting and short trips relieves pressure on roads and public transport networks, forms part of a healthy lifestyle for communities, and improves the amenity of public spaces. The Greater Sydney Principal Bicycle Network, part of the *Greater Sydney Services Infrastructure Plan* is co-designed with councils and builds on the commitment in *Future Transport 2056* to support people cycling for short trips within and between centres, including the provision of safe and accessible cycleways. The *Walking and Cycling Program* provides grants for active transport projects proposed by councils and NSW Government agencies every year and directly enables healthy and active travel. Around \$710 million will be invested into walking and cycling infrastructure over the next four years. This will bring the NSW Government's total investment to around \$1.1 billion.

### Parramatta active transport link

Transport for NSW will build a new shared walking and bike riding path, also called an active transport link, for the Greater Parramatta region as part of the Parramatta Light Rail program. The Parramatta Light Rail active transport link will generally run parallel to the light rail corridor between Camellia and Carlingford, making getting around these precincts safer and easier by providing good connections to local shops, parks, community facilities and public transport. This five kilometre path will connect with the Parramatta Valley Cycleway at Rydalmere, supporting the City of Parramatta Council's broader pedestrian and cycling network.

## Influencing travel choices

New transport projects create opportunities to reduce emissions by shaping transport behaviours and redistributing journeys to more efficient and sustainable modes, times and routes. Transport for NSW projects are now required, as part of their business cases, to consider opportunities for influencing travel demand. Travel demand management complements the NSW Government's *Movement and Place Framework*, to promote sustainable transport networks, precincts and neighbourhoods.

Travel Choices is Transport for NSW's public-facing sustainable travel behaviour change program. The program started in 2015 as a free resource to help individuals, businesses and organisations prepare for and adapt to changes to Sydney's transport network occurring during construction of the CBD and South-East Light Rail. From 2015 to 2019, there was a 13% decrease in private vehicles entering the Sydney CBD in the morning peak and a nearly 15% increase in public transport trips to the CBD, despite additional demands on the CBD from new development. This is the combined result of the Travel Choices program, implementation of traffic management strategies, increased public transport services and pedestrian priority and ongoing advertising campaigns.

The program was expanded to the Northern Beaches to support the introduction of the new services to the Northern Beaches in late 2017, and to Macquarie Park in 2018 to support the upgrade of the Epping to Chatswood Rail Line for Sydney Metro North West.

## Smart services

Mobility-as-a-service (MaaS) is a growing market with a range of players working together to offer customised mobility options for seamless travel when this is not available using main transport routes. Transport for NSW launched the Transport Digital Accelerator in 2018 to facilitate collaboration between the public and private sectors, connecting teams from the Transport cluster with industry, researchers, entrepreneurs and start-ups in the digital space. Transport for NSW has integrated several MaaS products into its Trip Planner and developed the world's first data specification for sharing planned and real-time information, including capacity information. The service will provide multi-modal solutions, including active transport options, to help meet future transport demand efficiently and sustainably.

### Mobility-as-a-service pilot

The first MaaS pilot challenge included five industry participants who received seed funding, incubation support, web service hosting, space at Sydney Start-up Hub, partner mentoring and coaching, exclusive access to data and application programming interfaces, and access to transport experts. The challenge aimed to answer the question, 'How would you give customers an ideal door-to-door mobility service experience and seamless combinations including the first and last mile options?'. There were six MaaS pilots in progress as of December 2020.

## Regulating to reduce transport emissions

The most effective tool for reducing vehicle emissions in New South Wales and Australia to date has been adoption of progressively tighter national vehicle emissions and fuel quality standards under Australian Design Rules and the *Fuel Quality Standards Act 2000*. Cleaner fuels and improved emission controls have substantially reduced emissions over time, even though freight, commercial and passenger travel and economic productivity have continued to grow.

The NSW Government has consistently advocated for strengthened standards and will continue to work with other jurisdictions to support harmonising national vehicle and fuel standards with the latest European standards, as representing international best practice.

In New South Wales, the POEO Clean Air Regulation includes provisions to prevent excessive emissions from vehicles, which are supported by community reporting of smoky vehicles. Campaigns targeting smoky vehicles and tampering with pollution controls are undertaken by the EPA in cooperation with police and Transport for NSW officers.

The Clean Air Regulation also mandates volatility limits on petrol supplied in Sydney during the summer months, to reduce petrol evaporation and subsequent formation of harmful ozone pollution. Average ozone in New South Wales is increasing and exceedances of ozone standards are occurring before the start and after the end of the current summer petrol volatility season, most likely due to the impacts of climate change. The remake of the Clean Air Regulation is proposed to expand the season for summer petrol volatility limits by a month to align with the period in which hotter temperatures are occurring and raising the risk of ozone exceedances.

To reduce ozone formation, the EPA has also worked closely with industry and local government to implement vapour recovery measures required under the Clean Air Regulation at petrol service stations across metropolitan areas of New South Wales. The NSW Government will improve information and guidance to assist councils to fulfil their regulatory role as part of the update of the NSW *Local Government Air Quality Toolkit*.

Environmental impact statements for new transport projects assess transport emissions and the department's planning approvals include conditions requiring air monitoring. Transport for NSW collates air monitoring undertaken around new road projects as part of planning approval conditions for such projects.

The EPA has increased transparency about how operational road tunnel ventilation stacks are regulated by amending the POEO Act. The EPA now regulates road tunnel ventilation stacks through environment protection licences. New licences include air emission limits consistent with approval conditions and some licences require pollution studies to be undertaken.

## Reduced emissions from non-road equipment and vehicles

While on-road vehicle emissions have declined as a result of national vehicle emissions and fuel quality standards, emissions from non-road mobile sources such as mining and construction equipment, locomotives and shipping have increased in the absence of national standards and regulation. Feasible and cost-effective technologies are available to control emissions and many overseas jurisdictions, including the United States and European Union, have mandated emissions standards for non-road diesel sectors.

Under the *National Clean Air Agreement*, the department is co-leading a project with the Commonwealth to evaluate the potential for a national approach to managing emissions from non-road diesel sources. The project builds on the national *Product Emissions Standards Act 2017*, which has so far established emissions standards for small spark ignition (i.e. petrol) engines used in equipment such as lawn mowers, gardening tools, generators, pumps, chainsaws and small boats.

The NSW Government also leads by example in requiring procurement of cleaner diesel equipment under the *NSW Government Resource Efficiency Policy (GREP)*. The policy requires purchase of lower emissions equipment and products by Government agencies, seeks to improve performance of Government contractors and provides a model for local governments.

Progress has been made on reducing harmful emissions from shipping with global shipping fuel sulfur limits of 0.50% coming into force from January 2020. The limits are adopted under the *International Convention for the Prevention of Pollution from Ships*, to which Australia is a signatory, and implemented by the International Maritime Organization.

The NSW regulatory framework for managing emissions from diesel locomotives has been strengthened by amendments to the POEO Act. Under the revised regulatory framework, rolling stock operators (operators of freight and passenger trains), in addition to railway infrastructure operators, are now required to hold environment protection licences.

The EPA commenced licensing operators of freight and passenger trains from August 2020. The rolling stock operators' environment protection licences require new locomotives to meet particulate matter emission limits. The EPA will work collaboratively with the rail industry on further measures to progressively reduce air pollution from all locomotives operating in New South Wales.

## 4. Healthier households

### Proposed Government actions

#### Empower local government

- Support councils to better manage smoke from wood heaters through improved guidance, tools and assistance.

#### Integrate air quality protections in the planning system

- Review planning instruments and guidance, including the Building Sustainability Index (BASIX), to support reduced energy/heating demand by households.

#### Improve knowledge about the impacts of wood smoke

- Participate in research on wood smoke, including emissions of black carbon or soot (as a short-lived climate pollutant) from wood heaters.

### Wood heaters

For some people, particularly in rural areas, wood heaters are the only viable and cost-efficient form of heating. The NSW Government recognises the importance of wood heaters in some communities and has no intention to implement a statewide ban.

Smoke from home wood heaters, especially if they are not used correctly, can however contribute significantly to fine particle emissions. Wood smoke has greater impacts in more populated areas, areas that experience colder winters with high heating needs, and areas that form basins where wood smoke is trapped over homes under common autumn and winter weather conditions.

In New South Wales, day-to-day management of wood heater emissions is at the local government level, supported by NSW Government regulatory controls and guidance and resources for council compliance and education. The POEO Act provides local councils with powers to issue smoke abatement notices to mitigate emissions of excessive smoke.

Significant improvements to promote more efficient wood heaters were made through the 2016 amendment to the POEO Clean Air Regulation, setting out minimum emission and efficiency standards for new wood heaters in New South Wales. These emission and efficiency limits were tightened further from 1 September 2019.

Proper wood heater operation and maintenance plays a critical role in minimising wood heater emissions and ensuring the benefits of strict emissions standards are realised. The EPA supports programs and campaigns, including targeted education for households, and has provided an effective package of education materials for use by local councils. Available in five languages, the package aims to raise broad community awareness about health impacts of wood smoke, and encourage better wood heater operation and shifts to cleaner forms of home heating.

In some areas of Sydney already subject to high pollution levels and where the population is growing and becoming denser, installation of wood heaters is restricted by local planning controls. Planning measures can also reduce wood heater emissions by supporting efficient housing that reduces heating demand, and clean and efficient technologies such as reverse cycle air-conditioning, coupled with renewable energy to meet residual demand.

The *NSW Electricity Strategy* and *Net Zero Plan* will also deliver household-focused programs to help promote energy efficiency and reduce heating needs and emissions.

The NSW Government will continue to strengthen its partnership with local government and communities to provide a combination of public education, financial assistance to householders and regulatory measures to deliver long-term and widespread wood smoke emission reductions and public health benefits.



- 1** Clean your **chimney** every year.
- 2** Use only **dry, aged, untreated** wood.
- 3** Use **small logs** instead of one large one.
- 4** Don't let your fire **smoulder** overnight.
- 5** Consider a **cleaner** heating method.

EPA council resource kit for wood smoke emissions



## 5. Better places

### Proposed Government actions

#### **Integrate air quality considerations systematically into strategies, plans, policies and guidelines for creating healthy and liveable places**

- Explore additional ways to embed air quality considerations within the planning framework.
- Reduce harmful air emissions and minimise people’s exposure to pollution by incorporating principles and considerations of sustainability, greening and a risk-based approach to hazards into the proposed Design and Place State Environmental Planning Policy.
- Promote walking and cycling as zero emission everyday transport through investment in walking and cycling programs, creating walkable, green networks and locating new housing within walking distance of green space, services and public transport nodes.
- Reduce demand for car use through considerations for fine-grained streets, lower parking rates and greater connectivity to recreational walking and cycling routes.
- Plan infrastructure, agriculture, industrial and urban service lands and new and infill residential developments to protect existing uses and minimise exposure of sensitive land uses to emissions and odour.

#### **Make places more resilient to population growth and changing climate**

- Plan and design new and infill development areas to be climate sensitive and minimise energy demand from homes and transport; for example, incorporate green roofs and facades into building design.
- Incorporate green infrastructure such as open space, tree canopy and other vegetation into urban developments to deliver air quality and amenity benefits.
- Support further research into using vegetation to improve air quality outcomes.

#### **Investigate opportunities to improve the built environment to increase sustainability and resilience to extreme events**

- Review existing programs and rating tools for sustainable and energy efficient buildings and precincts to identify opportunities to improve indoor air quality, particularly during extreme pollution events.

### Integrated planning for clean air

As New South Wales’s cities and regions grow and change, NSW agencies are collaboratively developing strategic land-use planning policies and legislation that seek to enhance air quality and public health, and are delivering these through best practice urban planning and design approaches.

Integration of air quality considerations at the earliest stage of the planning process is necessary to achieve clean air together with other planning objectives. For example, the Greater Sydney Commission’s *Greater Sydney Region Plan: A Metropolis of Three Cities* recognises air pollution as an urban hazard to be addressed in creating a resilient city. This principle is reflected in the district plans and several local strategic planning statements developed by councils within Sydney to enable the Greater Sydney Region Plan at the district and local level. Air quality considerations are also being integrated into related planning instruments to manage Sydney’s growth, such as *Wilton 2040: A Plan for the Wilton Growth Area*.

There are also significant opportunities to improve air quality through place-based planning for sustainable and resilient precincts and neighbourhoods. Planning and design for energy-efficient and renewably powered businesses and homes, integrated with green infrastructure and connected by sustainable modes of transport can deliver significant air quality benefits. Policy and science arms of NSW environment, planning, transport and health agencies will continue to share new research and investigate new opportunities to improve processes for integrated planning that deliver multiple community benefits, including cleaner air.

## Protecting sensitive land uses

A key role for land-use planning is to address potential conflicts between air-sensitive land uses, such as residential, and activities such as freight transport, port activities, industry and agriculture. Land-use planning can support appropriately locating competing uses and provide for separation or staged transitions, for example from agricultural to residential use, to minimise air quality impacts.

This is important to minimise both population health impacts and potential constraints on the activities to support future productivity and employment for a growing city (Greater Sydney Commission 2018). It is important to address early planning for new places as areas transform in response to growth. For example, air pollution impacts are being considered up-front in master planning for the Special Activation Precincts that will deliver projects to support major new businesses and industry, including renewable energy, in dedicated areas of regional New South Wales.

Sydney's growth involves major new transport projects together with intensified high-density residential development and other sensitive land uses along transport corridors. Higher density residential and commercial development along transport routes meets objectives for a compact, affordable and productive city and improves access to public transport, key services and employment. However, dense residential development along transport corridors increases the risk of population exposure to transport emissions.

The transition to electric vehicles will not entirely eliminate roadside pollution as non-exhaust particle emissions from road, brake and tyre wear continue to increase with increased road usage and heavier vehicles. Local pollution can be worsened along roads if high-rise buildings form road canyons that concentrate pollutants.

Measures that can be investigated by planning authorities and proponents include buffer areas, mechanical ventilation with the air intake located away from the roadway, and design of buildings to promote dispersion of traffic emissions. Mechanical ventilation combined with filtration can help protect sensitive land uses not only from traffic pollution, but air pollution generally, including pollution generated by extreme events such as bushfires and dust storms. Land-use planning will be complemented by strong regulation to minimise air impacts.

## Integrating green infrastructure into the built environment

'Green infrastructure', as defined in the NSW Government Architect's *Greener Places: An urban green infrastructure framework*, is the network of green spaces, natural systems and semi-natural systems that support sustainable communities. It includes waterways; urban bushland; tree canopy and green ground cover; parks, and open spaces that include parks; and open spaces that are strategically planned, designed and managed to support a good quality of life in the urban environment.

Urban environments that prioritise and are integrated with green infrastructure support health and wellbeing, environmental resilience and local economies. They can also contribute to reducing urban air pollution. The benefits of green infrastructure and its role as essential infrastructure are being increasingly recognised, including in two of the *Premier's Priorities*:

- Increase the proportion of homes in urban areas within 10 minutes' walk of quality green, open and public space by 10% by 2023.
- Increase the tree canopy and green cover across Sydney by planting one million trees by 2022.

Recent local and international research has shown that green infrastructure, including open space, trees and vegetation, can play an important role in improving air quality by assisting in the uptake, transport and assimilation (or, in some cases, decomposition) of gaseous or particulate pollutants as well as reducing overall particle pollution in urban areas. Additional benefits arise when vegetation is located to physically separate people from pollution sources, such as roads and industry, and to reduce local exposures.

The benefits of green infrastructure are increasingly recognised. For example, one Sydney study found that trees along the Pacific Highway and Parramatta Road remove 13,000 kilograms of air pollution each year (Ghosh & Yung 2017). Further work is underway to develop a repeatable and reliable methodology to value green infrastructure, including its role in improving air quality. Valuing the air quality benefits of green infrastructure will provide a price signal on the value of green infrastructure and influence the way it is planned for and considered in NSW Government decision-making.



People stroll around Armidale Markets. Photo: DPE



## Keeping track

The department will regularly evaluate our air quality management progress under the *Clean Air Strategy* in our regular air quality reports, including:

- a NSW annual air quality statement on the department’s Environment, Energy and Science website, including reporting on air quality in NSW regions and on any major pollution events
- the annual Air NEPM Compliance Report published on the department’s website, which presents annual air quality monitoring data and assesses the data against the requirements of the Air NEPM
- a report on progress in managing air quality in the *NSW State of the Environment* report, updated every three years by the EPA.

Based on that evaluation, we will refine actions under the *Clean Air Strategy* to ensure we are meeting our goal of achieving ongoing reductions in the impacts of air pollution on the people of New South Wales.

Individual clean air initiatives will also be evaluated and refined to ensure the greatest gains for public health and the NSW community as they are rolled out.

The NSW Government applies rigorous economic analysis so its management strategies and specific control measures deliver the greatest net benefit to the community. The aim is to prevent pollution, at least cost to the community and business, and ensure any costs of pollution to the community are borne by the polluter.

The *NSW Clean Air Strategy* is complementary to the *Net Zero Plan Stage 1: 2020–2030* and other key Government strategies and will be delivered and reviewed over the same timeframe as the *Net Zero Plan*.



Cycling as transport. Photo: Peter Sherratt/DPE



## Working together towards cleaner air

Improving air quality across New South Wales requires input from many stakeholders, both within and outside government. This includes industry, business and community groups, environment and health experts, local government and the general public.

The NSW Government recognises, supports and values stakeholders' interest in being involved in air quality management, especially in their own local areas. The department uses diverse communication and consultation techniques and technologies to make data and information fully available and engage stakeholders on air quality issues, policies and projects. These include local community advisory committees, targeted workshops, community information sessions, public forums, direct consultation, surveys, online web tools and social media.

The NSW Government will continue to engage with Aboriginal communities and their representatives to ensure air quality management delivers equitable outcomes and integrates Aboriginal knowledge of working with the Country's natural systems, including fire regimes.

The department will continue to engage early, evaluate options and tailor and target engagement approaches to improve air quality responses and meet stakeholder needs. This will include exploring innovative ways to build and expand communication and engagement networks so all stakeholders have an opportunity to be involved, to share and receive information about air quality issues that matter to them and provide feedback on projects where they live.



Doug Sky lookout, Mount Kaputar National Park. Photo: Simon Cottrell/DPE

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CSE 2020, *Opportunities for prosperity in a decarbonised and resilient NSW: Decarbonisation Innovation Study*, Chief Scientist and Engineer, viewed 13 January 2022, [chiefscientist.nsw.gov.au/\\_data/assets/pdf\\_file/0004/321466/Final-Report-Decarbonisation-Innovation-Study.pdf](https://chiefscientist.nsw.gov.au/_data/assets/pdf_file/0004/321466/Final-Report-Decarbonisation-Innovation-Study.pdf) (PDF 2.8MB).

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## Appendix: Information supporting the Clean Air Strategy

The Clean Air Strategy is supported by substantial evidence from monitoring, modelling and assessment of population exposure and health impacts from air pollution. The NSW State of the Environment report provides the latest information on air quality and other key environmental issues in New South Wales.

The Strategy commits to continuous development of the evidence base on air pollution and the health impacts. As new evidence becomes available, it will be used to inform the evaluation of the actions in the Strategy. There are four main areas of evidence and further information:

- **Monitoring:** Monitoring long-term trends in air quality is important to our understanding of ongoing exposures of NSW populations to pollution and the effectiveness of our strategies.
- **Pollution sources:** Since air pollution comes from many different sources, it is important to know the contribution each source makes in order to develop the best approaches for improving air quality.
- **Exposure:** Airshed modelling provides information on the dispersion and transformation of emissions and how population exposure varies within an airshed.
- **Health:** Health impact studies inform our understanding of air pollution exposure and the related health impacts.

### Monitoring

#### Long-term trends

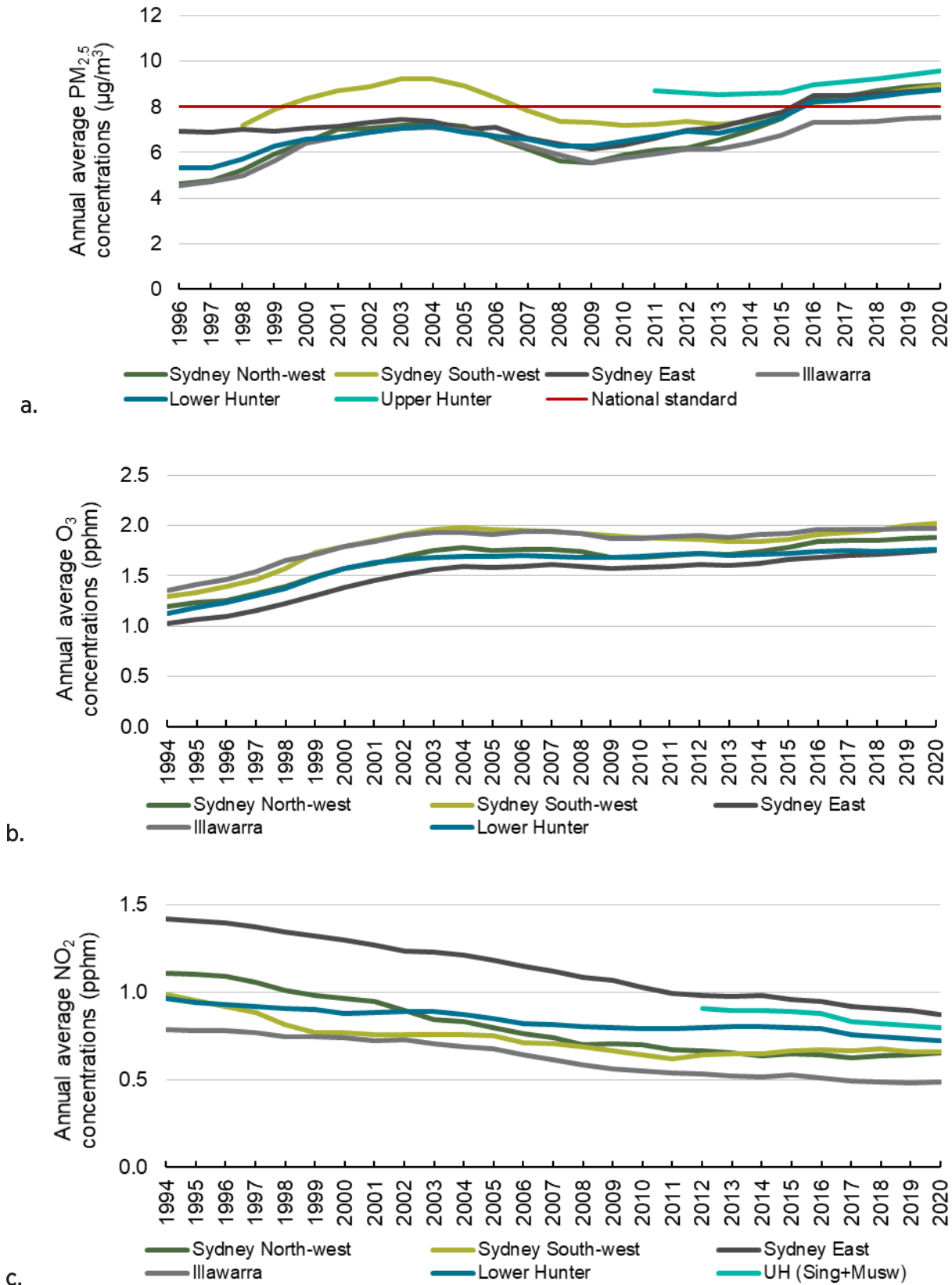
Monitoring long-term trends in air quality is important to our understanding of ongoing exposures of NSW populations to pollution and the effectiveness of our strategies in reducing the risks to human health from pollution.

Population growth, urbanisation, transport and industrial activities and climate change impacts will all challenge future air quality improvements unless new measures are taken to reduce human-made emissions and improve long-term trends.

While annual average fine particle (PM<sub>2.5</sub>) levels improved during the first decade of the century, concentrations have been trending higher in recent years (Figure 6a). PM<sub>2.5</sub> levels for the Sydney region (including North-west, South-west and East sub-regions) have exceeded the annual standard in some years and the Upper Hunter has consistently experienced elevated PM<sub>2.5</sub> levels since monitoring began there in 2011, due to both natural and human-made particle emissions. In the last two to three years, drought and the 2019–20 bushfire season have had a major impact, pushing particle levels across New South Wales far above the annual standard.

Ozone (O<sub>3</sub>) annual average levels increased during the 1990s and have remained stable in recent years (Figure 6b).

Nitrogen dioxide (NO<sub>2</sub>) annual average concentrations gradually declined between 1994 and 2012 but improvements have slowed, and levels have plateaued in the last decade (Figure 6c).



**Figure 6 NSW air quality trends, 1997-2020: annual average fine particle (PM<sub>2.5</sub>), ozone (O<sub>3</sub>) and nitrogen dioxide (NO<sub>2</sub>) concentrations**

**Notes:** The data is smoothed to show the long-term trend.  
 µg/m<sup>3</sup> = microgram per metre cubed; pphm is parts per hundred million.  
**Source:** NSW DPIE 2021, NSW Air Quality Data Services monitoring data



## Poor air quality days

Days of high pollution are a critical focus for air quality management as these can produce serious acute health impacts, particularly in vulnerable populations. Poor air quality days are most typically caused by particle pollution. Sydney and the Illawarra can experience poor air quality days due to both ozone and particle pollution.

Air quality varies across NSW regions due to differing local pollution sources, both natural and human-made, and the complex dispersion and atmospheric transformation of local and regional emissions.

Major particle exceedance days generally coincide with major fire or dust events. The impact of the drought from mid-2017 and the 2019–20 bushfires is seen across all New South Wales. The year 2019 was the driest and warmest on record for New South Wales and the impact of climate change is expected to increase the frequency and intensity of extreme dust and fire pollution events in the future.

In the last decade, air quality in New South Wales has generally met national standards for:

- 70–85% of days in the Sydney region
- 80–90% of days in the Illawarra and Hunter regions
- 90% or more days on the Central Coast (since 2012 when air quality monitoring commenced) and in the regional cities of Albury, Bathurst, Tamworth and Wagga Wagga (referred to as ‘Regional NSW’ in Figure 7).

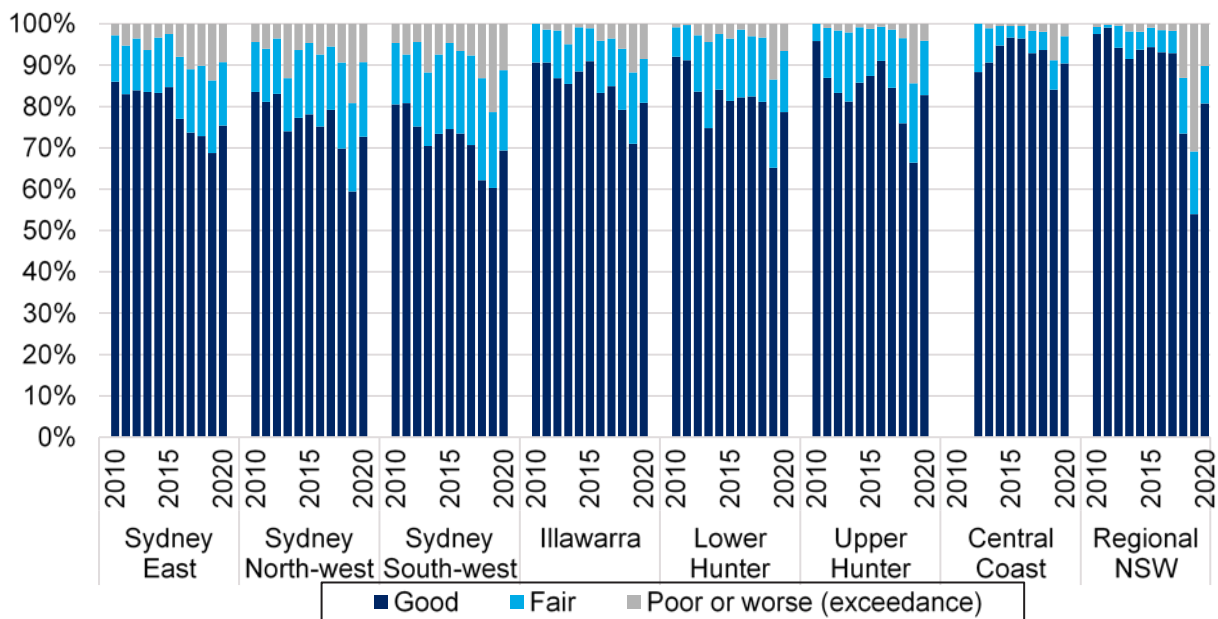
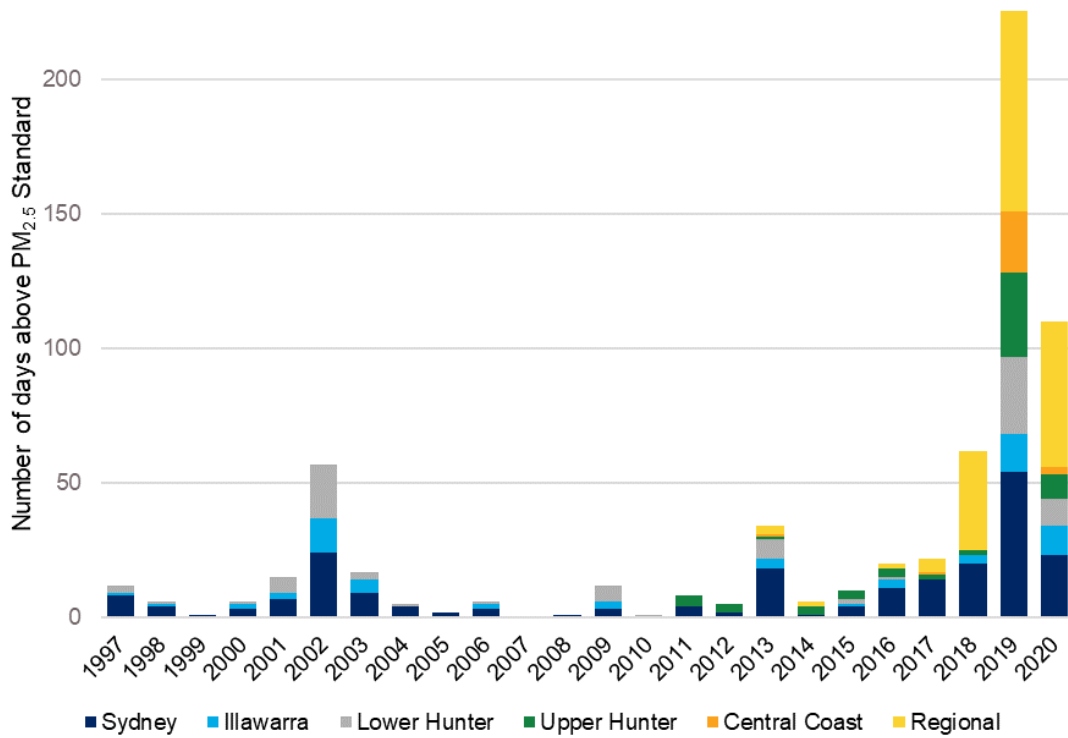


Figure 7 Air quality in Sydney sub-regions and NSW regions, 2010–2020

**Note:** Monitoring commenced in Central Coast in 2013.

**Source:** NSW DPIE 2021, NSW Air Quality Data Services monitoring data

Sydney typically has more fine particle ( $PM_{2.5}$ ) exceedance days than other regions, while the Central Coast experiences a very low number of  $PM_{2.5}$  exceedance days (Figure 8). The 2019–20 bushfires resulted in a high number of poor air quality days across several locations in New South Wales.

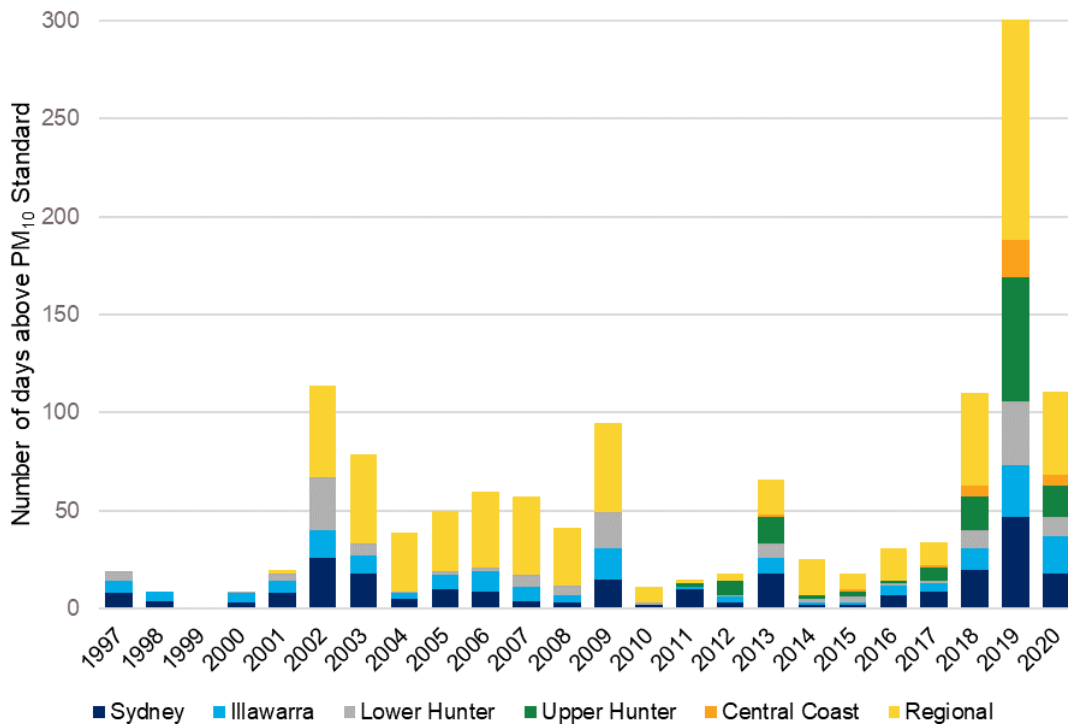


**Figure 8** Number of PM<sub>2.5</sub> exceedance days in NSW regions, 1997-2020

**Note:** Regional PM<sub>2.5</sub> monitoring started in Wagga Wagga and Upper Hunter in 2011, Bathurst and Tamworth in 2016, and Albury in 2017.

**Source:** NSW DPIE 2021, NSW Air Quality Data Services monitoring data

The regional NSW cities experience considerably more PM<sub>10</sub> exceedances than the urban centres, primarily due to windborne dust (Figure 9).

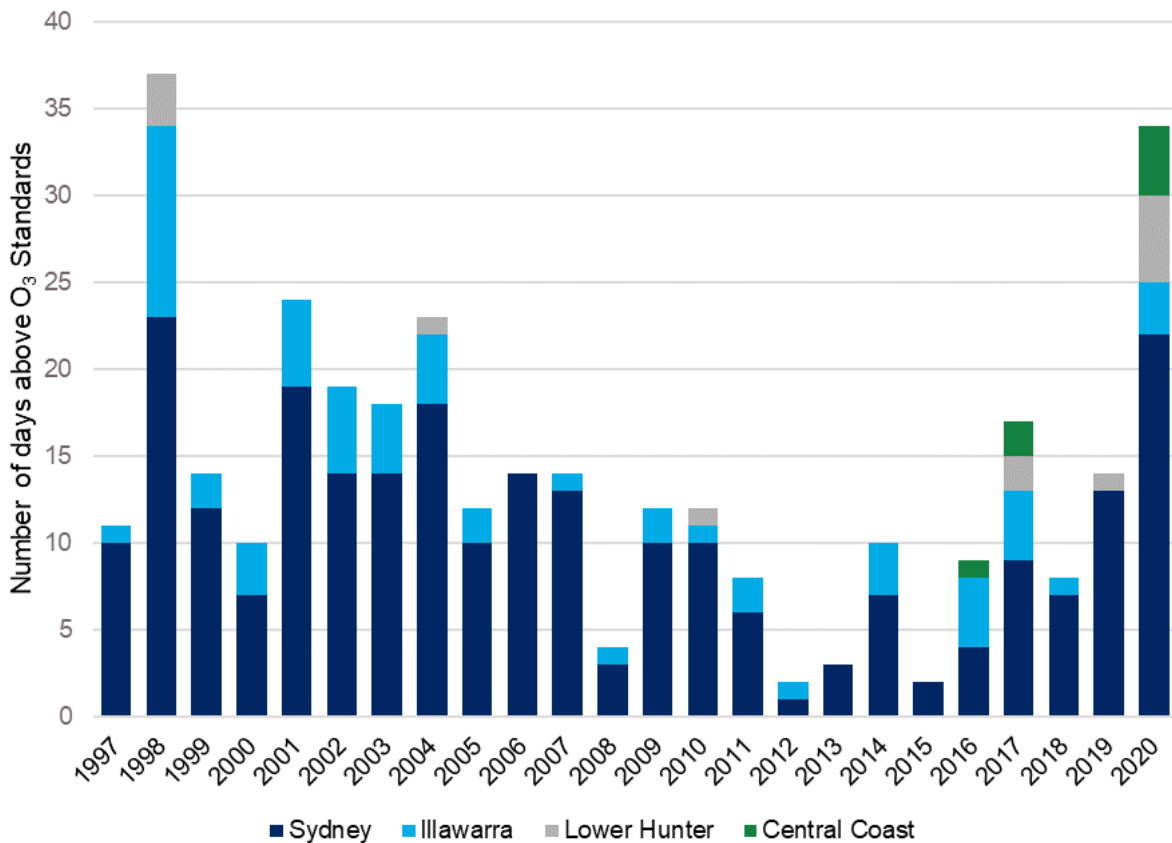


**Figure 9** Number of PM<sub>10</sub> exceedance days in NSW regions, 1997-2020

**Note:** PM<sub>10</sub> monitoring commenced in NSW regional centres in 2002.

**Source:** NSW DPIE 2021, NSW Air Quality Data Services monitoring data

Ozone can be an issue, mostly in Sydney with some occurrences in the Illawarra and infrequent occurrences elsewhere (Figure 10). High ozone in Sydney and the Illawarra can result from local precursor emissions, or smog, or precursors transported from other regions. Exceedances of the ozone standards usually occur in warmer months, peaking during high temperatures and during regional bushfires. Years with more hot days have more ozone exceedances and climate change is expected to lead to a further increase in ozone exceedance days.



**Figure 10** Number of ozone (O<sub>3</sub>) exceedance days in the Greater Metropolitan Region, 1997–2020  
 Source: NSW DPIE 2021, NSW Air Quality Data Services monitoring data

### Fire and dust storms

Air pollution from extreme events has significant health impacts. Bushfires and dust storms are a large source of exposure to particle pollution due to the very high pollution levels that can occur over large areas and populations.

Careful planning and management go into minimising any impacts of smoke from hazard reduction burns used to mitigate bushfire risk. Nonetheless, hazard reduction can occasionally contribute to elevated levels of air pollution, particularly affecting those communities close to the burn.

Figure 11 shows the number of air quality days in 2019 in the hazardous category. In 2019 the major contributors to days with air quality in the worst or ‘hazardous’ category in New South Wales were bushfires, dust storms and, on occasion and in specific locations, hazard reduction burns. In late 2020, air quality data was updated to nationally consistent air quality categories. Previously the ‘hazardous’ category in New South Wales was defined as more than twice the national standard.

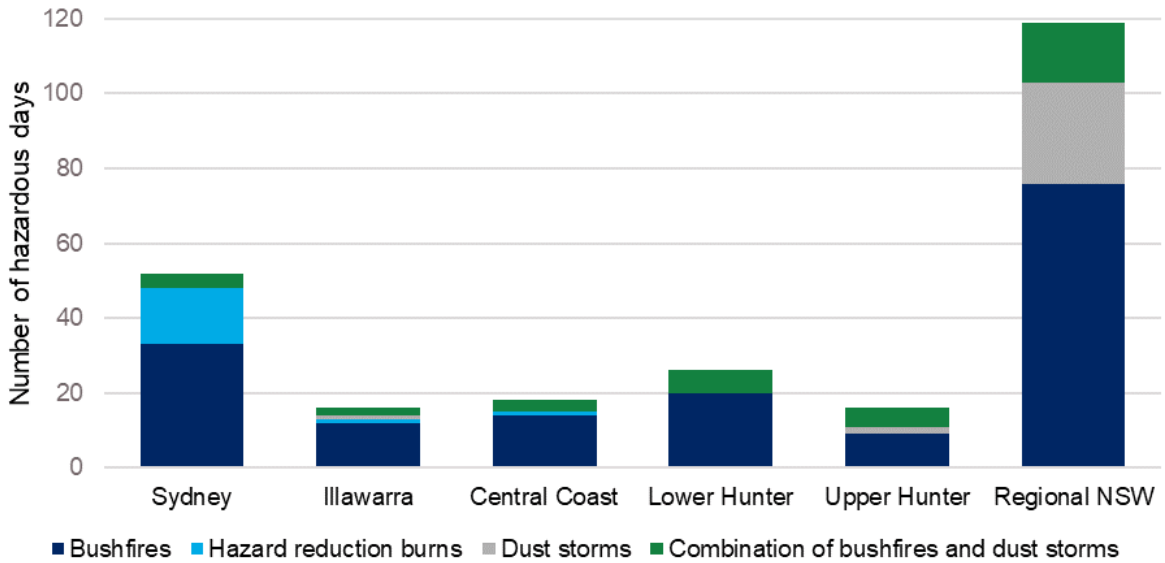


Figure 11 Air quality days in hazardous category, 2019

Source: NSW DPIE 2021, NSW Air Quality Data Services monitoring data

Severe fire weather (defined as a Forest Fire Danger Index (FFDI) of greater than 50) is projected to increase across New South Wales over the coming decades, particularly in the western areas of the State (Figure 12). The number of severe fire days varies significantly from year to year, but an overall increase in bushfires and days when particle levels are hazardous is expected.

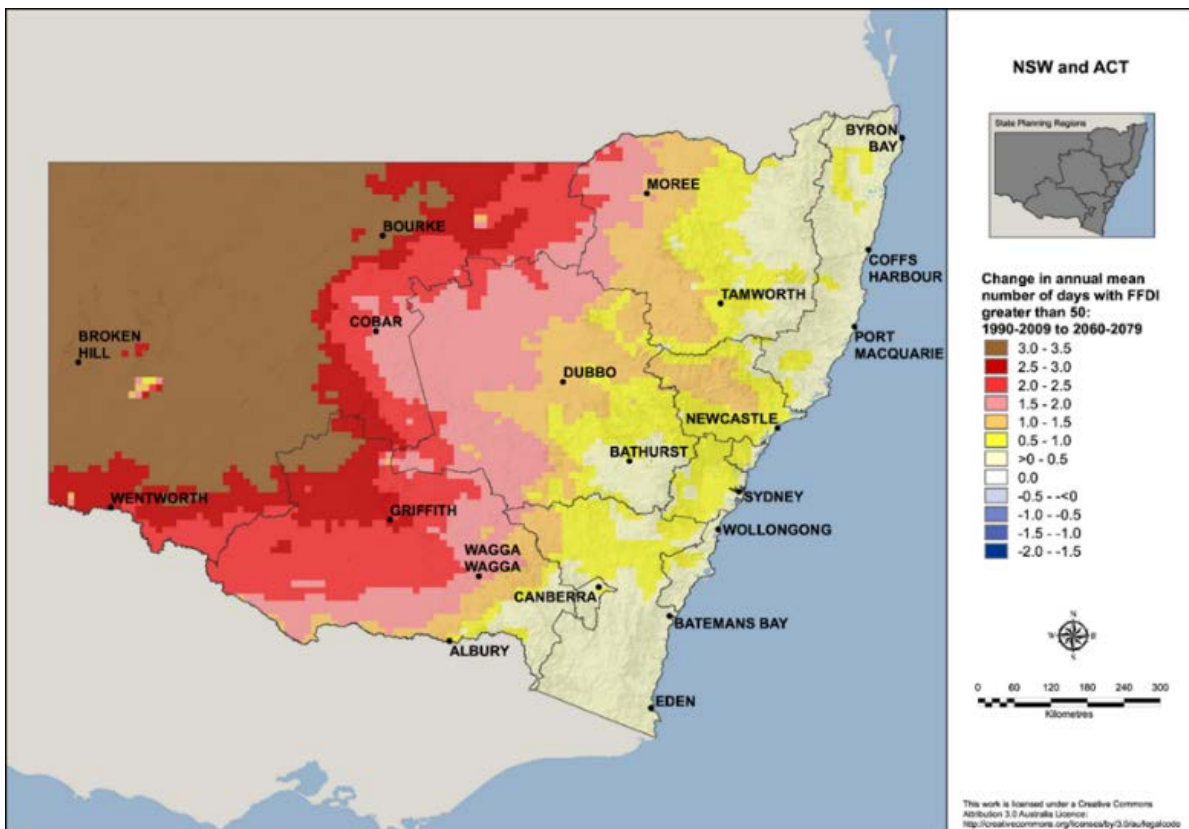


Figure 12 Predicted increase in severe fire days (i.e. days with Forest Fire Danger Index, FFDI, >50), 2060–2079

Source: NSW DPIE 2021, NSW Climate Projections Map for 2060–2079 interactive map

## Pollution sources

### Where does pollution come from?

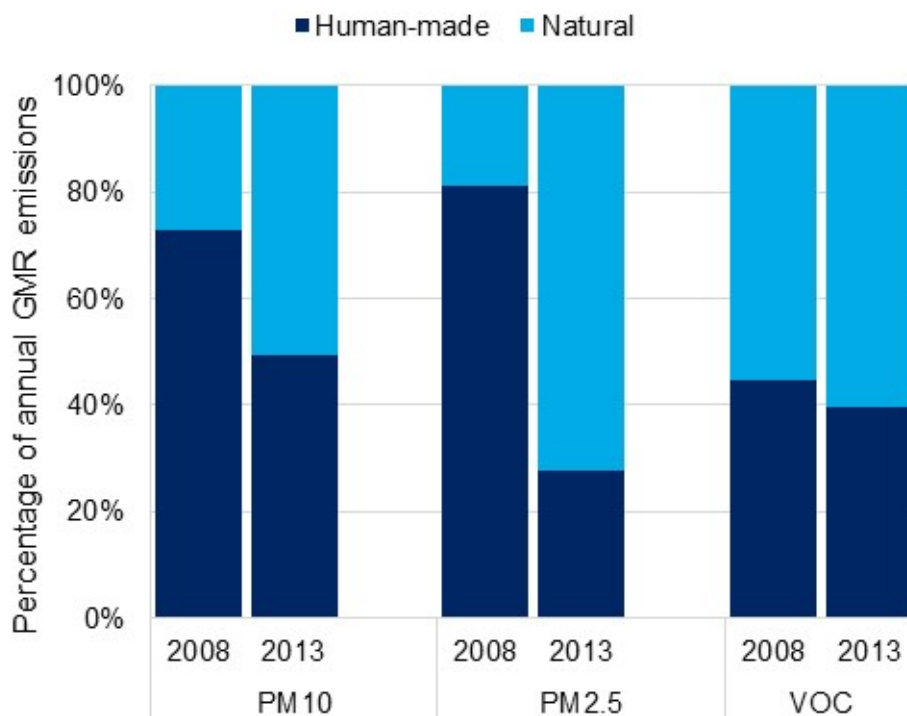
Since air pollution comes from many different sources, both natural and human-made, it is important to know the contribution each source makes in order to develop the best approaches for improving air quality. Air pollution arises from direct emission of primary pollutant gases and particles, and by formation in the atmosphere of secondary pollutants such as ozone and secondary particles from reaction of precursor primary emissions.

New South Wales has an Air Emissions Inventory for the Greater Metropolitan Region in NSW for 2003, 2008 and 2013. The NSW Greater Metropolitan Region (GMR) inventories include natural and human-made emissions from domestic and commercial premises, on-road and off-road transport, as well as industrial emissions. The GMR inventories identify the most significant sources of emissions, where they are released and how emission levels change over time.

### Natural sources

Natural sources of particle emissions include landscape fires (e.g. bushfires, grass fires, hazard reduction burns, etc.), sea salt and windborne dust from both local and continental sources, including from exposed agricultural land. Vaporisation of volatile organic compounds (VOC) from vegetation, including from many native plants, is also a major contributor to ozone formation in hotter months.

Natural emissions vary significantly from year to year due to climatic influences, with drought increasing dust and bushfire risks. The inventories show the large contribution of natural particle emissions in the NSW GMR in 2013 due to significant bushfires, relative to the much lower contribution in 2008 (Figure 13).



**Figure 13** Contribution of human-made and natural sources to annual emissions in the NSW Greater Metropolitan Region (GMR)

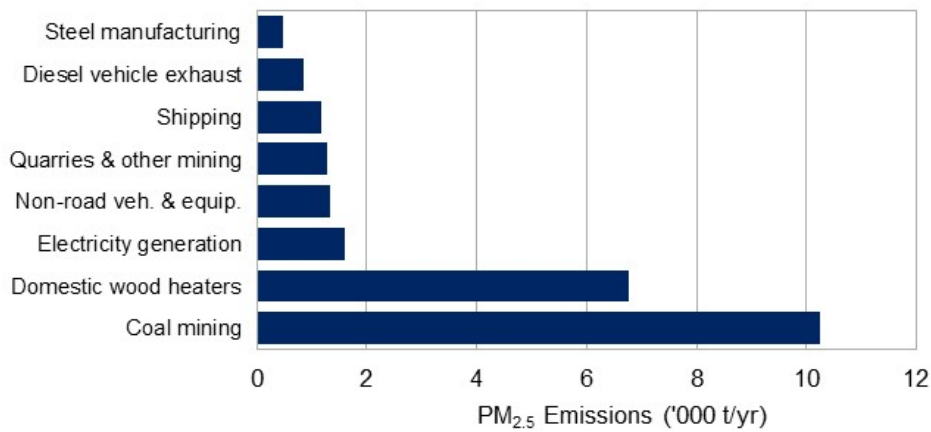
Source: NSW Environment Protection Authority 2021, Air Emissions Inventory for the Greater Metropolitan Region in NSW

## Human-made sources

In the 2013 NSW GMR inventory, human-made emission sources are grouped in the following sectors:

- industry sources – industries licensed by the Environment Protection Authority such as mining, power generation, steel manufacturing and waste management
- transport, fuels and engines – on-road vehicles, off-road vehicles and equipment including mining and construction equipment, ships and boats, domestic and commercial lawn and garden equipment, and fuel storage and distribution
- domestic sources – such as wood heaters, aerosol products and solvent use and paints
- commercial activities – such as fuel retailing, smash repairs, dry cleaning, printing and agriculture.

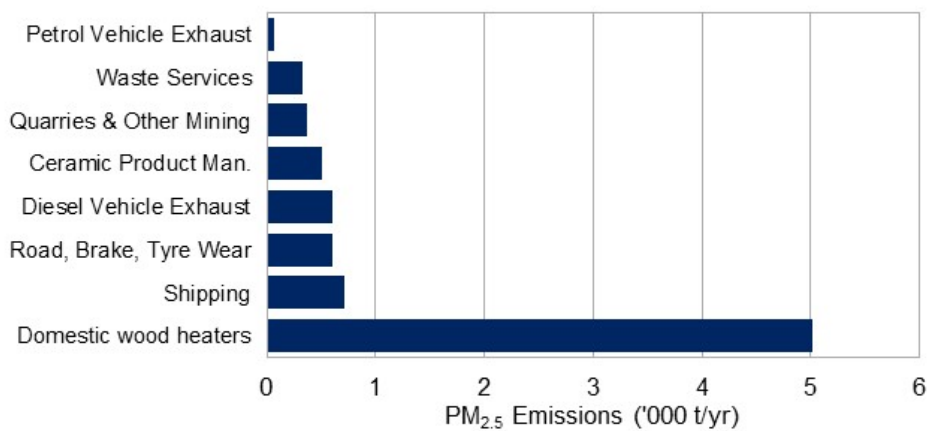
The 2013 GMR inventory shows the largest primary sources of human-made fine particles as coal mining, domestic wood heaters, electricity generation and non-road diesel equipment (Figure 14).



**Figure 14** Top primary human-made sources of fine particle (PM<sub>2.5</sub>) emissions (tonnes/year) in NSW Greater Metropolitan Region in 2013

Source: NSW Environment Protection Authority 2021, Air Emissions Inventory for the Greater Metropolitan Region in NSW

Within Sydney, the major fine particle source is domestic wood heating. Shipping, road brake and tyre wear particles from on-road vehicles also contribute (Figure 15).



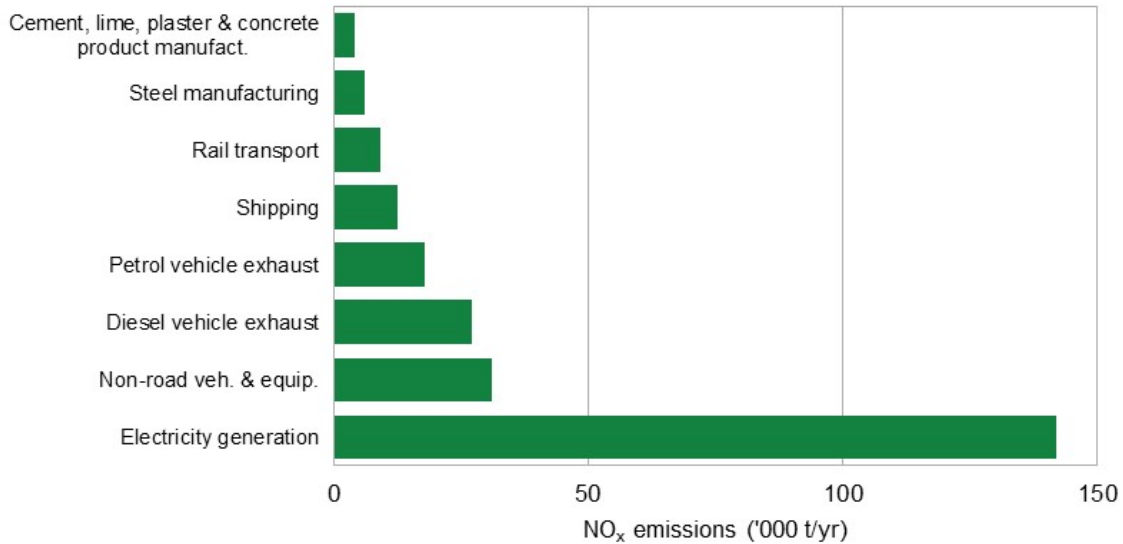
**Figure 15** Top primary human-made sources of fine particle (PM<sub>2.5</sub>) emissions (tonnes/year) in Sydney in 2013

Source: NSW Environment Protection Authority 2021, Air Emissions Inventory for the Greater Metropolitan Region in NSW

### Sources of secondary pollution precursor emissions

Effective air quality management also depends on controlling the precursor emissions of secondary pollution of ozone (i.e. nitrogen oxides and VOC) and of secondary particles (including sulfur dioxide, nitrogen oxides, VOC and ammonia). Secondary particles may account for about half the fine particle concentrations in Sydney during the summer months.

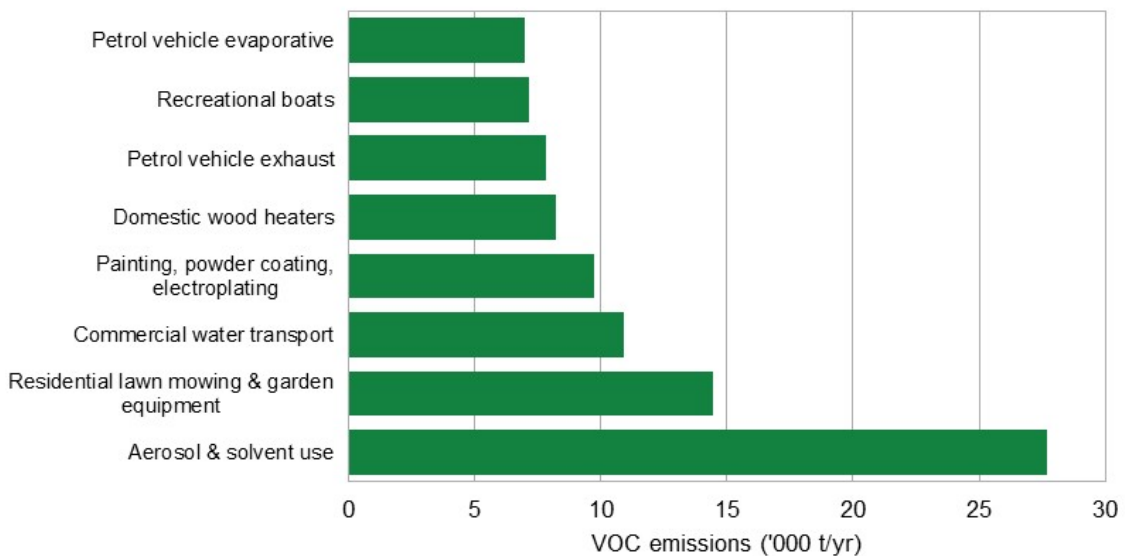
Electricity generation is the major source of nitrogen oxides in the NSW GMR (Figure 16).



**Figure 16 Nitrogen oxides (NO<sub>x</sub>) (tonnes/year) were one of the top sources of ozone and fine particle forming pollutants in NSW Greater Metropolitan Region in 2013**

Source: NSW Environment Protection Authority 2021, Air Emissions Inventory for the Greater Metropolitan Region in NSW.

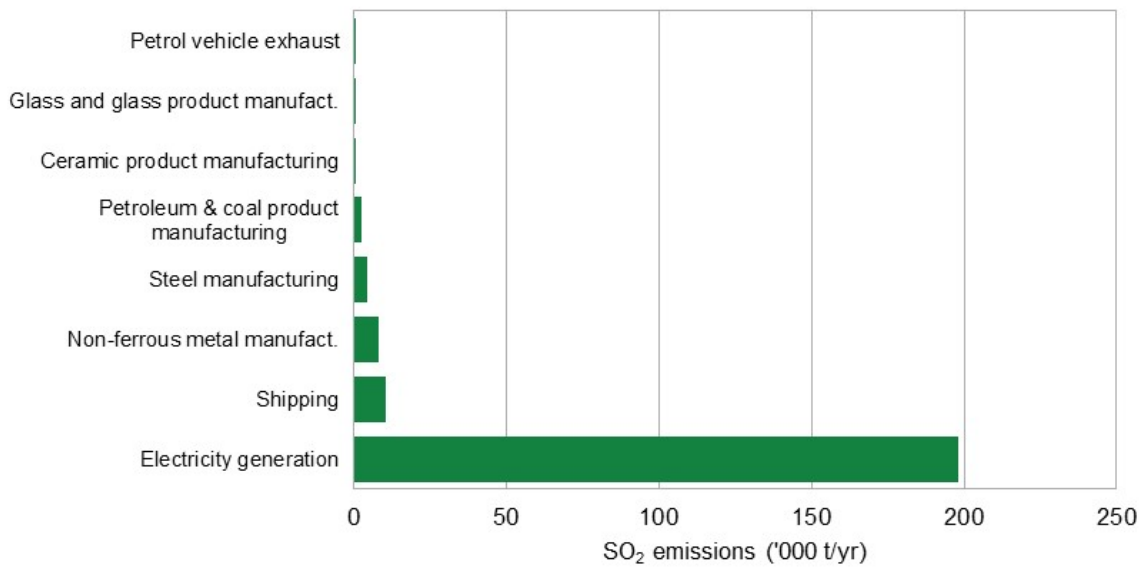
Domestic sources are significant contributors of human-made VOC emissions (Figure 17).



**Figure 17 Volatile organic compounds (VOCs) (tonnes/year) were one of the top sources of ozone and fine particle forming pollutants in NSW Greater Metropolitan Region in 2013**

Source: NSW Environment Protection Authority 2021, Air Emissions Inventory for the Greater Metropolitan Region in NSW.

Electricity generation is the dominant source of sulfur dioxide emissions in the GMR (Figure 18).



**Figure 18** Sulfur dioxide (SO<sub>2</sub>) (tonnes/year) was one of the top sources of ozone and fine particle forming pollutants in NSW Greater Metropolitan Region in 2013

Source: NSW Environment Protection Authority 2021, Air Emissions Inventory for the Greater Metropolitan Region in NSW.

## Exposure

### How and where populations are most affected

The degree to which communities are exposed to pollution from any specific source depends not only on the amount of the emissions released, but also on other factors including:

- how the emissions are released
- the meteorology and topography of where they are released
- how emissions may be transformed by chemical reactions in the atmosphere
- where the resultant pollution ends up in relation to communities.

Airshed modelling predicts annual average ambient concentrations of pollution at a fine spatial scale, based on how emissions are dispersed and transformed within the airshed. When combined with spatial population data, this enables estimation of a single metric for population exposure. This metric is ‘the population-weighted annual average concentration’.

### Population exposure to fine particles in the GMR and contributing emission sources

The NSW Government’s Atmospheric Research group has conducted airshed modelling for the GMR based on the 2013 NSW air emission inventory as part of the ongoing Sydney Air Quality Study for the NSW Greater Metropolitan Region. It included modelling of the GMR’s population exposure to fine particles (PM<sub>2.5</sub>).

Figure 19 shows the population-weighted annual average fine particle (PM<sub>2.5</sub>) exposure (in bold) and also presents this as a percentage of the 8 microgram per metre square (µg/m<sup>3</sup>) national standard for fine particle emissions. The pie chart shows the proportion of natural and human-made emissions contributing to the overall population exposure.



Exposure to natural and human-made sources of PM<sub>2.5</sub> can be broken down in modelling to exposure to particular sources. The latest information can be found on the department’s Environment, Energy and Science *Clean Air Strategy* webpage (DPE 2022).

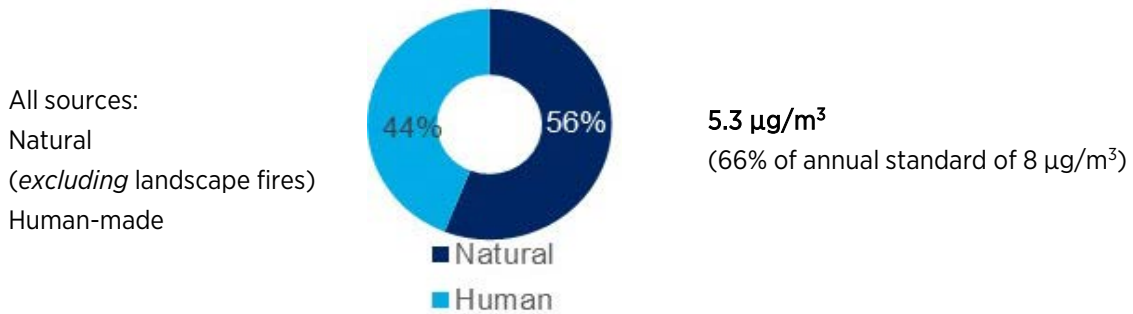


Figure 19 Greater Metropolitan Region population-weighted annual average PM<sub>2.5</sub> exposure in 2013

## Health impacts

### Health impacts of air pollution

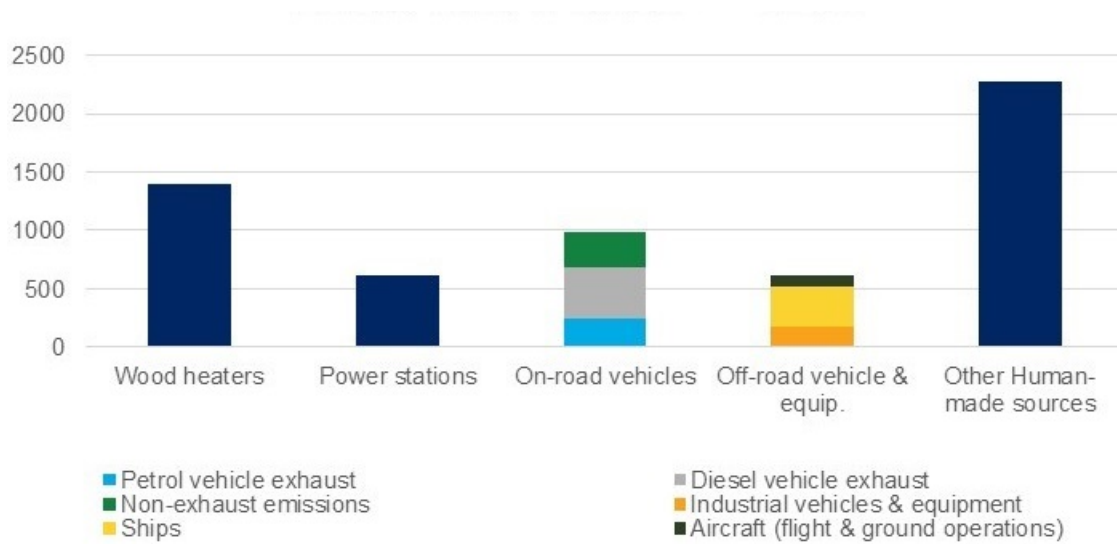
High levels of air pollution can cause severe acute health conditions, and even low levels of pollution that meet air quality standards can harm people if they are exposed over the long term. Vulnerable people, including the elderly, children and those with chronic health conditions are generally the most affected.

Extensive international health research provides very strong evidence that long-term exposure to fine particle pollution shortens lives and hastens the development of cardiovascular and respiratory disease.

The health impacts of air pollution are assessed using widely accepted epidemiological methodologies which estimate the degree to which people’s lives are shortened due to long-term exposure to air pollution. This is commonly expressed in terms of the years of life lost (YOLL) by society on an annual basis.

The Environment Protection Authority and NSW Health sponsored researchers from the Centre for Air pollution, energy and health Research (CAR) and the Commonwealth Scientific and Industry Research Organisation (CSIRO) to conduct an independent assessment of the health impacts caused by human-made, fine particle pollution for the GMR that occurred in 2010–11.

The study used airshed modelling to perform a full health impact pathway assessment of emissions from four major particle sources, with on-road vehicles and off-road vehicles and equipment each split into three further sub-sources. Figure 20 shows the findings of the study expressed as total years of life lost per annum for the major sources of human-made particle pollution. The impacts from ‘other human-made sources’ in Figure 20 predominantly arise from a wide range of industrial activities.



**Figure 20 Total estimated years of life lost per annum for major sources of human-made particle pollution in the GMR**

More information is available in a copy of a presentation of this study at the 2017 NSW Clean Air Summit (Broome 2017) and in the published journal paper (Broome et al. 2021).

## Further information

Protection of public health from air pollution and health impact assessment is informed by an extensive body of health research, from both Australian and international sources. A selection of links to further information is provided below.

### Australian

- [NSW Health](#) air quality health impacts information
- National Environment Protection Council:
  - [Summary for Policy Makers of the Health Risk Assessment on Air Pollution in Australia](#)
  - [Health Risk assessment for Ambient Air Quality Review Stage 2](#) – O3, NO2 and SO2
  - [Health Risk assessment for Ambient Air Quality Review Stage 1](#)
- [Centre for Air pollution, energy and health Research \(CAR\)](#)

### International

- [Committee on the Medical Effects of Air Pollutants \(COMEAP\)](#)
- World Health Organisation:
  - [Air pollution overview](#) and links
  - [Health risks of air pollution in Europe \(HRAPIE\)](#)
- [United States AirNow Air Quality and Health overview](#) and links
- [United States Health Effects Institute](#)

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