2 Atmosphere

2.1 Air quality

New South Wales complies with national air quality standards for four of the six major 'criteria' air pollutants: carbon monoxide, nitrogen dioxide, sulfur dioxide and lead. However the national standards continue to be exceeded in some regions for the other two pollutants – ozone (on up to 16 occasions a year) and particle pollution (up to 21 times a year). Levels of air toxics are generally low, with periodic assessment required to verify that all remain at acceptable levels.

Air quality in NSW has improved significantly since the 1980s with initiatives to reduce urban air pollution implemented across industry, business, homes and motor vehicles. The concentrations of a number of the most common air pollutants (such as ammonia, carbon monoxide, lead and sulfur dioxide) are low and since the early 1990s emissions of these and other pollutants (including oxides of nitrogen and volatile organic compounds) have been reduced by 20–40% across the Sydney region.

Ground-level ozone (a key component of photochemical smog which appears as white haze in summer) remains an issue for Sydney and concentrations generally continued to exceed national air quality standards on up to 16 days a year between 2009 and 2011.

There is growing evidence about the adverse health impacts of airborne particles. Particle pollution (appearing as brown haze) generally meets standards in Sydney except when bushfires or dust storms occur, though concentrations exceeded national air quality standards on up to 18 days a year from 2009 to 2011. Some areas in regional NSW exceeded the particle standards on as many as 21 days a year over the same period, with bushfires, stubble burning, dust storms, coal mine dust and woodheaters the major causes.

NSW indicators

Indicator and status	Trend	Information availability
Concentrations of ozone	Stable	✓✓✓
Concentrations of particles (PM_{10})	Stable	✓✓✓
Concentrations of carbon monoxide	Stable	✓✓✓
Concentrations of nitrogen dioxide	Stable	✓✓✓
Concentrations of sulfur dioxide	Stable	✓✓✓
Concentrations of lead	Stable	✓✓✓

Notes: Terms and symbols used above are defined in *About SoE 2012* at the front of the report.

Introduction

Clean air is fundamental to everyone's wellbeing. Poor air quality can be particularly critical to the health of children, older people, pregnant women and those with pre-existing health conditions, while also affecting the natural environment and liveability of the communities in which we work and reside.

An air pollutant is any substance in the air that can harm humans or the environment. Pollutants arise from both natural processes, such as plant respiration, dust storms and bushfires, and human (anthropogenic) activities, and may take the form of solid particles, liquid droplets or gases.

Air pollutants may be classified as *primary* or *secondary*. A primary pollutant is a substance directly emitted from a process, such as carbon monoxide from a motor vehicle exhaust. Secondary pollutants form in the air when primary pollutants react with other substances or interact with each other. An example of a secondary pollutant is ground-level ozone, one of the many secondary pollutants that make up photochemical smog. Some pollutants may be both primary and secondary: examples include formaldehyde, particles, ozone and nitrogen dioxide.

Toxic chemicals are an additional class of air pollutants that can have an impact on human health and the environment. These are generally only found in trace amounts in airsheds across NSW and so are subject to less intensive monitoring.

The status and trend of carbon dioxide and other greenhouse gases, including manufactured chemical pollutants, are discussed in People and the Environment 1.2.

Australians spend approximately 85% of their time indoors, much of it in the home (EPHC 2004). As a result, personal exposure to airborne substances may be more closely related to those encountered indoors than outdoor air pollution. This is accentuated by the close proximity of indoor emissions to people and because the small amounts of pollutants emitted can accumulate to higher concentrations than they would outdoors due to ineffective dispersion and dilution.

The primary concern with indoor air pollution is the link between pollutants and human health. Some of the pollutants found in indoor air are suspected of contributing to long-term human health effects (and even premature death), such as cancer and damage to the nervous, immune and reproductive systems. Other pollutants (nitrogen dioxide, formaldehyde and fine particles) can cause more immediately observable health effects, such as irritation of the upper respiratory system and breathing difficulties, especially for at-risk groups like those with asthma or other lung problems, very young children and older people. Pollutants from tobacco smoke can lead to respiratory and heart disease, cancer and foetal harm.

Costs of poor air quality

Air pollution is a persistent health concern in major cities in Australia and around the world. Those particularly susceptible to the health impacts of air pollution are the very young (because they are generally more active outdoors and their lungs are still developing), the elderly and those with pre-existing health conditions.

Since the early 1990s a substantial body of research has been published about the adverse health effects of air pollution. The research suggests that air pollution – even at the relatively low levels common in many urban environments of industrialised countries – is a risk factor for health. An increasing range of adverse health effects has been linked to air pollution, especially fine particles.

Short-term exposure to elevated air pollutants exacerbates existing respiratory and cardiovascular problems and increases the risk of acute symptoms, hospitalisation and death (EPHC 2010). Long-term repeated exposure increases the risk of chronic respiratory and cardiovascular disease and mortality, has an impact on birth weight, and can permanently affect lung development in children (Pope 2004; Pope & Dockery 2006).

The health costs of air pollution at 2005 levels in the Greater Metropolitan Region (GMR_2) were estimated to be $4.7 billion or $893 per head of population (DEC 2005). Looking at motor vehicle pollution alone, the Australian Bureau of Transport and Regional Economics estimated health costs of $3.3 billion per year in the country's capital cities with Sydney's share $1.5 billion (BTRE 2005).

Defining the major pollutants

A range of air pollutants is commonly found across many parts of Australia. Certain key air pollutants that are regulated or subject to standards based on criteria related to health and/or environmental effects are known as 'criteria' air pollutants.

To help protect the health of the Australian population, the National Environment Protection Council in 1998 set ambient air quality standards and goals for six criteria pollutants in the *National Environment Protection (Ambient Air Quality) Measure* (AAQ NEPM). The six pollutants in the AAQ NEPM are ground-level ozone, particles (as PM_{10}), carbon monoxide, nitrogen dioxide, sulfur dioxide and lead.

In addition, an Advisory Reporting Standard for $PM_{2.5}$ was introduced in 2003. The AAQ NEPM was recently reviewed and the recommendations are to be incorporated into the development of a National Plan for Clean Air (see 'National responses' below).

To measure compliance with national goals, NSW has established an extensive air quality monitoring network across the state (see 'Responses' below). The network provides up-to-date air quality information to the community through the Environment Protection Authority (EPA) website and a linked system of email and SMS health alerts for high pollution days as well as the Sydney forecast.

Status and trends

The AAQ NEPM goal for each pollutant sets the maximum number of days on which the relevant standard (a specified concentration of the pollutant) may be exceeded. NSW consistently meets the goals for carbon monoxide, nitrogen dioxide, sulfur dioxide and lead. Ozone and particles continue to be problematic.

Ozone

Ozone is present in both the upper atmosphere (stratosphere) and the lower atmosphere (troposphere). The ozone in the stratosphere (commonly called the 'ozone layer') protects human, animal and plant health by reducing the levels of the Sun's damaging UV-B radiation reaching the Earth's surface. Stratospheric ozone is not a pollutant and is not included in this chapter.

In contrast, ozone at ground level is an air pollutant that is harmful to human health and the environment. People exposed to elevated concentrations of ozone for several hours at a time are at increased risk from respiratory irritation and changes in lung function, particularly if they are already suffering a respiratory illness (WHO 1998).

Ozone is formed in the lower atmosphere when a number of 'precursor' compounds – mainly oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) – react in warm, sunny conditions. (Carbon monoxide is a lesser source of ozone as well.) Major anthropogenic sources of NO_x and VOCs include emissions from industrial facilities, electric power stations and motor vehicle exhausts, and fumes from engines used in garden equipment and recreational boats as well as paints, aerosols and solvents used in homes and businesses. It is also important to note that natural sources, such as eucalyptus trees, contribute approximately 55% the total emissions of volatile organic compounds in the GMR_2.

Elevated ozone concentrations occur in the Sydney and Illawarra regions during the warmer months when meteorological conditions and the surrounding topography prevent the NO_x and VOC constituents from dispersing. Ozone concentrations across Sydney and the Illawarra can be significantly affected by weather patterns: cloudy cool weather tends to lead to low levels, while hot sunny days result in more exceedences (DECCW 2010). Since days with high ozone occur more frequently in summer, the incidence of elevated ozone concentrations may be exacerbated by future climate change, which is expected to bring more hot sunny days.

The AAQ NEPM sets two standards for ozone: a 1-hour standard of 0.10 parts per million (ppm) and a rolling 4-hour standard of 0.08 ppm. The NEPM goal for ozone stipulates that by 2008 the maximum allowable number of exceedences for each of these standards is one day per year. Between 2008 and 2011, the NEPM ozone goals were met only once in Sydney – in 2008 for the 1-hour standard.

While 2011 was generally a good year for air quality in Sydney due to milder weather conditions, both of these ozone standards were exceeded. Indeed, either or both of the standards have been exceeded in Sydney every year since 1996 (**Figure 2.1**). Between 1994 and 2011, ozone concentrations in Sydney exceeded the 1-hour standard on up to 19 days per year, with four exceedence days in 2011. Over the same period, exceedences of the rolling 4-hour standard occurred on up to 21 days, with five exceedence days in 2011. Peak exceedences for both standards occurred in 2001.

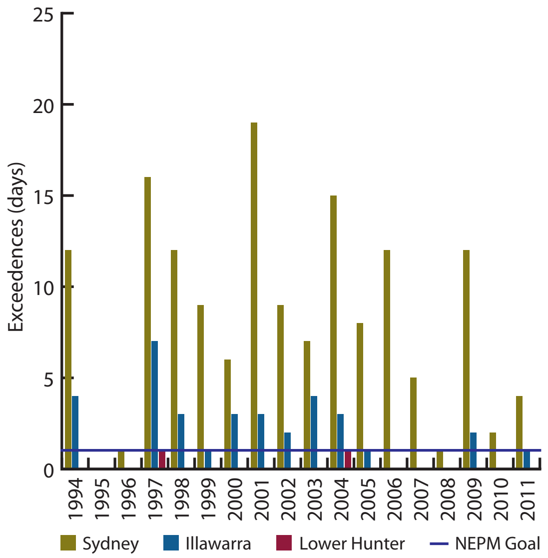
Over the same period, the standards were exceeded less frequently in the Illawarra, occurring on up to seven days per year for both standards (Figure 2.1). Either or both of the AAQ NEPM ozone standards were exceeded in the Illawarra on more than one day in 1994, 1997, 1998, 2000–04 and 2009. The Lower Hunter region recorded the fewest exceedences of the standards: neither standard has been exceeded more than once a year since 1997 (thus complying with the AAQ NEPM).

While all parts of Sydney can experience ozone concentrations above the AAQ NEPM standards at some time, the west and south-west of the city are the regions most often exposed as a result of summertime atmospheric circulation in the Sydney Basin (DECCW 2010).

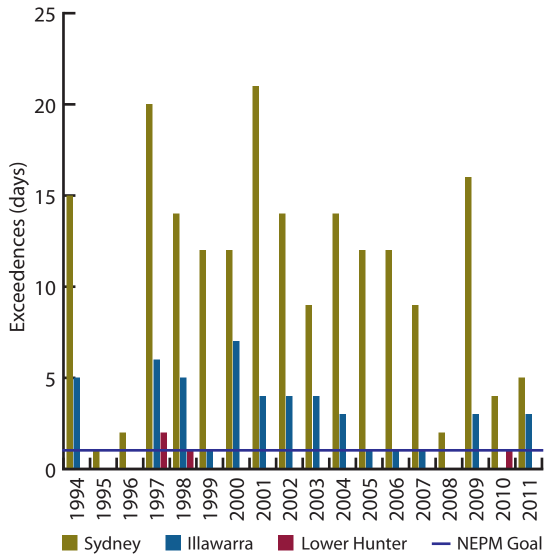
Figure 2.2 shows the maximum recorded concentrations of ozone for each region from 1994 to 2011. Over the period, maximum concentrations have been highest in Sydney and lowest in the Lower Hunter.

Figure 2.1: Exceedences of the AAQ NEPM standards for ozone in the GMR_2, 1994–2011

1-hour exceedences



4-hour exceedences

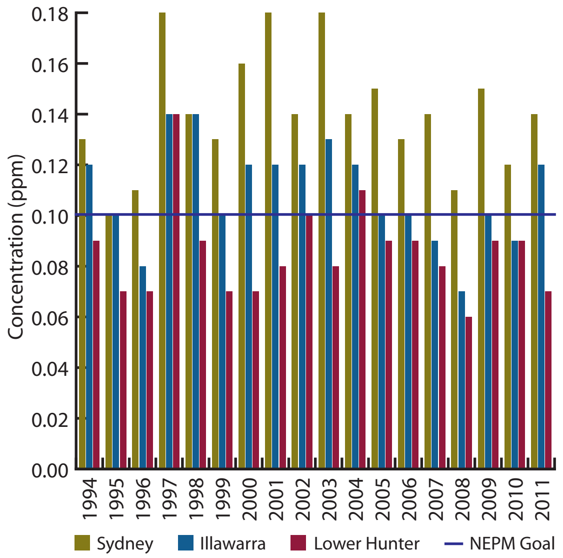


Source: EPA data 2012

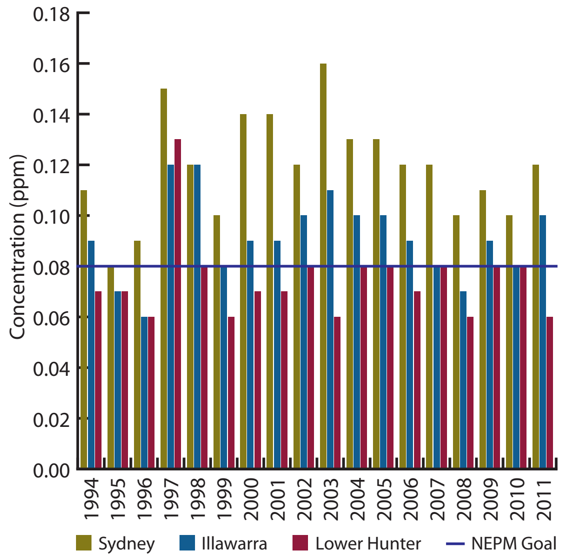
Note: The majority of the 1-hour and 4-hour ozone exceedences occur as single-day events. Thus, if more than one monitoring site exceeded the standard on a particular day, that day is counted only once.

Figure 2.2: Annual maximum 1-hour-average and 4-hour-average concentrations for ozone in the GMR_2, 1994–2011

1-hour-average (annual maximum)



4-hour-average (annual maximum)



Source: EPA data 2012

No notable trends are discernible in either the number of exceedences or maximum concentrations. The number of days when ozone standards are exceeded in any given year is strongly dependent on meteorological conditions, which vary from year to year. A statistical analysis to filter out most of the meteorological variability shows ozone concentrations in Sydney are not decreasing (**Figure 2.3**).

Bushfire events and hazard reduction burns are potentially significant sources of ozone precursors and can have an impact on ozone pollution: for example, Sydney bushfires at the end of 2001 contributed to five of the 19 exceedences of the 1-hour ozone standard in 2001 and two of the nine exceedences in 2002. Many of the weather conditions that lead to high bushfire danger are also conducive to the formation of ozone. Importantly, however, even without bushfires, emissions from human activities are sufficient to cause regular exceedences of the AAQ NEPM standards at one or more monitoring station in the region on the one day (DECCW 2010).

Particles

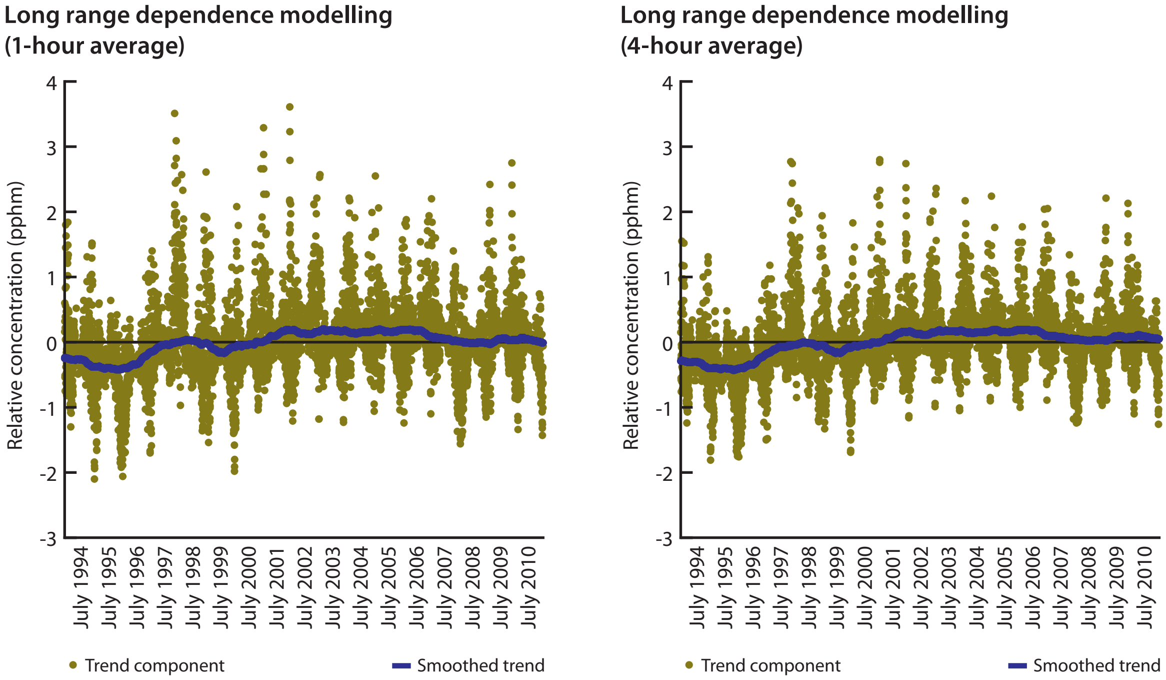
Even relatively low concentrations of particle pollution can cause health impacts in some individuals (WHO 2003). The concentration and size of the particles are important (WHO 2007) and these can vary greatly between sources, regions and seasons.

Particles smaller than 10 micrometres (µm) in diameter (PM_{10}) are consistently associated with increased mortality and hospital admissions for people with both heart and lung disease (Morgan et al. 1998a; Morgan et al. 1998b; Simpson et al. 2005a; Simpson et al. 2005b).

As an indication of how small these particles are, by comparison a human hair is around 70 µm in diameter. Research has demonstrated a link between chest colds in children and PM_{10} in the Hunter and Illawarra (Lewis et al. 1998) while long-term exposure to air pollution, including particles, has been linked to reduced life expectancy (Pope et al. 2002).

Health research identifies fine particles with a diameter smaller than 2.5 µm ($PM_{2.5}$) as a particular concern. In general terms, the smaller the particle the greater its impact on human health. Because of their smaller size, these particles can be inhaled more deeply into the lungs where the irritation can cause coughs, asthma and other lung conditions. Some are small enough to pass into the bloodstream through the finest blood vessels of the lungs where they can trigger heart attacks in people with existing lung or heart conditions and impact more severely on children and the elderly. These groups can be sensitive to even relatively low levels of particle pollution.

Figure 2.3: Long-term trend of daily maximum 1-hour-average and 4-hour-average concentrations for ozone in the Sydney Region, 1994–2010



Source: DECCW 2010

Notes: The trend is derived from a statistical analysis which removes major variations due to meteorological conditions and presents the variation in the trend in ambient ozone concentration relative to the data average.

Particles – as PM_{10}

The AAQ NEPM sets a standard for PM_{10} of 50 micrograms per cubic metre (µg/m³) (24-hour average). The goal set was that by 2008 the standard would not be exceeded on more than five days per year, thus making an allowance for the occurrence of extreme, potentially unavoidable events, such as dust storms, bushfires and hazard reduction burning.

The national standard for PM_{10} is generally being met in Sydney, the Illawarra and the Lower Hunter except in years with bushfires or dust storms (**Figure 2.4**). Bushfires in 1994 and 2001–03 were major contributors to the extremely high concentrations of particle pollution recorded in the GMR_2 in those years. Similarly, major statewide dust storms in September 2009 accounted for exceedences across the state. The number of exceedences varies greatly from year to year, as shown by the marked drop in 1999 and 2004. Hazard reduction burns on 10 March and 15 November 2011, along with local construction activity near some sampling stations, led to the 10 exceedences recorded that year.

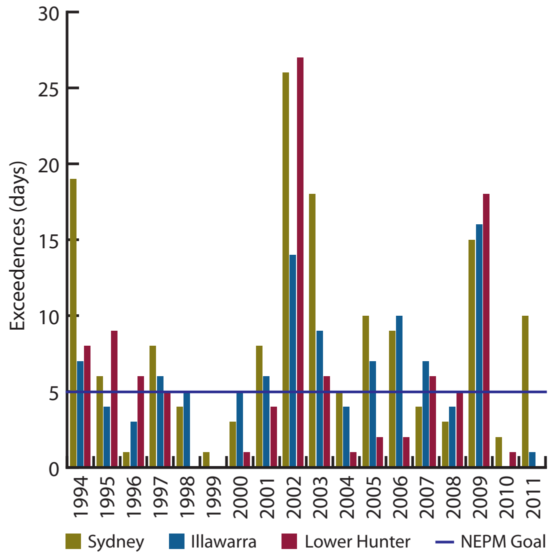
There is a strong seasonality in PM_{10} levels in the GMR_2: with bushfires and dust storms more prevalent in summer, the majority of exceedences occur in spring and summer (**Figure 2.5**).

The national goal for PM_{10} is not being met in some regional centres. The levels recorded in these centres are generally representative of the air quality in the surrounding regions. PM_{10} concentrations are monitored in Albury (NSW–Victoria border), Bathurst (Central Tablelands), Tamworth (North-West Slopes) and Wagga Wagga (South-West Slopes).

In 2003 and 2009, none of these regional cities met the PM_{10} goal of no more than five exceedences in a year (**Figure 2.6**). Albury, Bathurst and Tamworth have achieved the goal in some of the years shown, while Wagga Wagga has met the goal in only one, particularly wet, year – 2011.

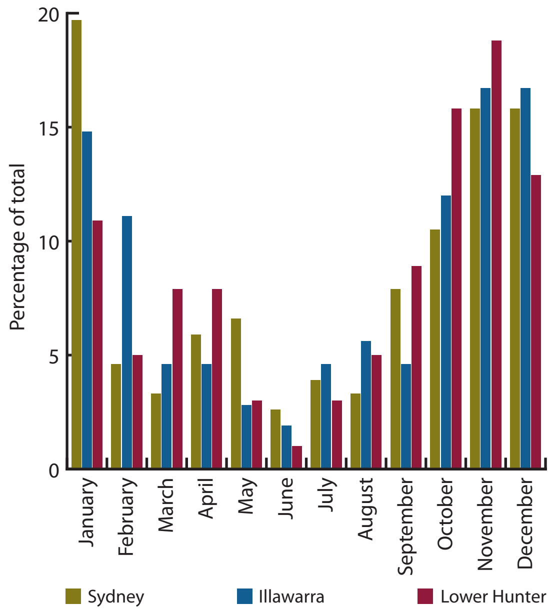
The general run of high exceedence years was due to factors such as dust storms, bushfires and other conditions associated with the prolonged drought, widespread agricultural stubble burning, and the use of woodheaters in the region. Elevated particle concentrations recorded at Albury and Wagga Wagga in January 2003 were the result of major bushfires in the ACT and NSW, and both also felt the impact of bushfires in Victoria in the summer of 2006–07.

Figure 2.4: Exceedences of the AAQ NEPM standard for particles (PM_{10}) in the GMR_2, 1994–2011



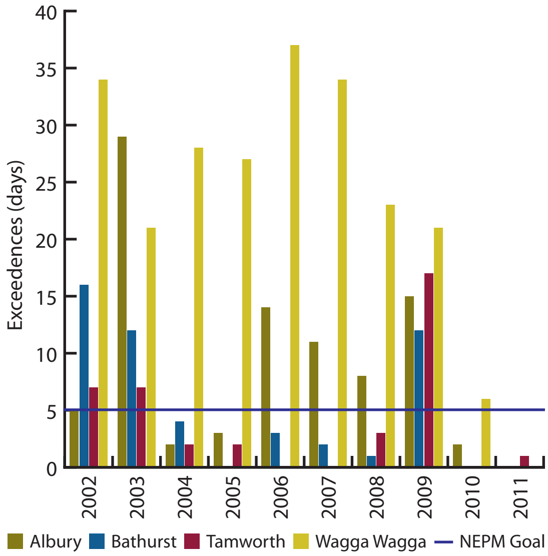
Source: EPA data 2012

Figure 2.5: Seasonal distribution of PM_{10} exceedence days in the GMR_2, 1994–2011



Source: EPA data 2012

Figure 2.6: Exceedences of the AAQ NEPM standard for particles (PM_{10}) in NSW rural cities, 2002–11



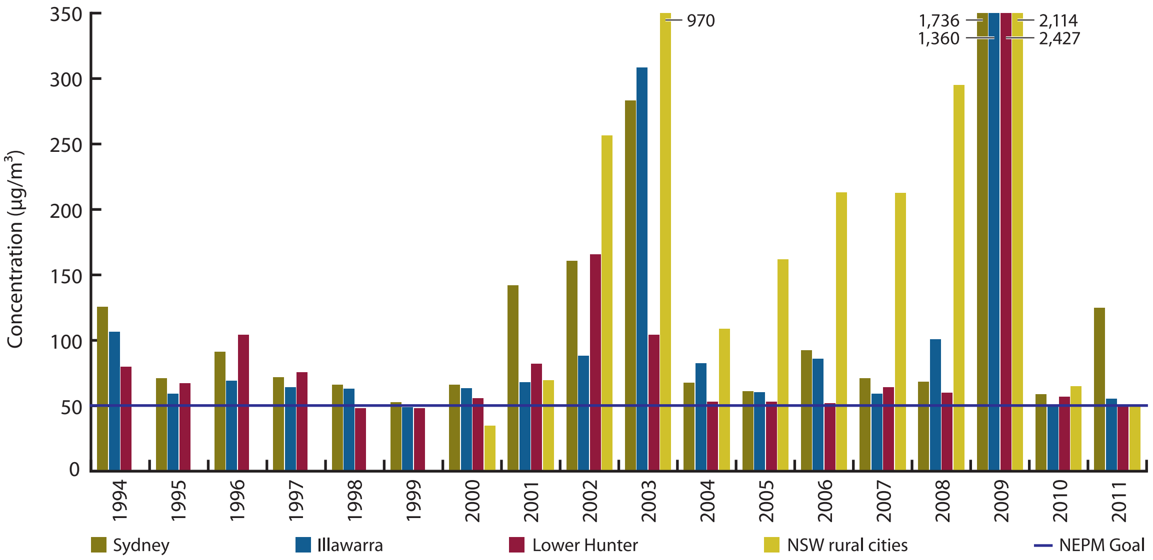
Source: EPA data 2012

While large-scale dust storms are uncommon events, they can result in widespread exposure to extreme levels of particles (DECCW 2010). For example, on 23 September 2009, the largest dust storm to hit NSW since air quality monitoring commenced resulted in extreme levels of particles over most of the state. The lower Hunter recorded the highest PM_{10} averages over 24 hours of 2427 µg/m³, nearly 50 times the standard of 50 µg/m³. Sydney, the Illawarra, Bathurst and Tamworth recorded PM_{10} concentrations ranging from 27 to 42 times the standard. This was followed three days later by a second, less intense dust storm across much of the state. The previous highest PM_{10} concentration recorded in NSW was at Wagga Wagga during a dust storm on 19–20 March 2003, when the PM_{10} 24-hour average registered 970 µg/m³ (almost 20 times the standard) (**Figure 2.7**).

The incidence of dust storms is a function of soil dryness, ground-cover density and wind speed (Lu & Shao 2001). The frequency of dust storms increases with the frequency of droughts: the dust storms in 2003 and 2009 were both associated with drought conditions. The incidence of drought is projected to increase as a result of climate change (CSIRO 2007) and so dust impacts on air quality may also be expected to increase.

PM_{10} exceedences in regional centres are most common in summer in Albury, Bathurst and Tamworth, and during autumn in Wagga Wagga (**Figure 2.8**).

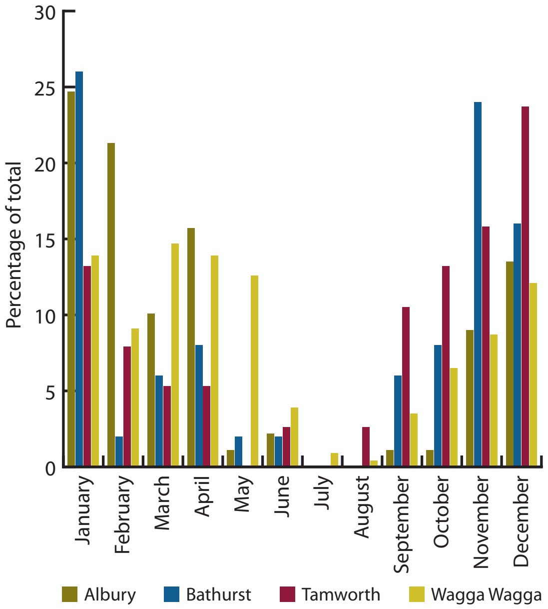
Figure 2.7: Annual maximum 24-hour-average concentrations for particles (PM_{10}) in the GMR_2 and NSW rural cities, 1994–2011



Source: EPA data 2012

Notes: Particles data prior to 2008, as presented in past NSW SoE reports, were calculated for the 24-hour period from 11 pm to 11 pm. For this report and in line with NEPM reporting standards, 24-hour-average PM_{10} concentrations have been recalculated to true calendar average (midnight to midnight).

Figure 2.8: Seasonal distribution of PM_{10} exceedence days in NSW rural cities, 2002–11



Source: EPA data 2012

Notes: Percentage is calculated for each city based on total exceedences of the AAQ NEPM standard for PM_{10} for the period 2002–11.

Particles – as $PM_{2.5}$

The AAQ NEPM was amended in 2003 to include two *advisory* reporting standards for $PM_{2.5}$ – a 24-hour average of 25 µg/m³ and an annual average of 8 µg/m³. NSW participated in the National Environment Protection Council's 2011 review of the AAQ NEPM. In part, this recommended making the $PM_{2.5}$ advisory reporting standard a compliance standard and introducing an exposure reduction framework for $PM_{2.5}$. The recommendations are being prioritised as part of the development of a National Plan for Clean Air (see 'National responses' below). The plan is due for submission to the Council of Australian Governments (COAG) by the end of 2014.

In NSW measured $PM_{2.5}$ concentrations have generally been at or below the 24-hour-average advisory reporting standard but above the annual average advisory reporting standard.

Figure 2.9 shows the highest daily average concentration of $PM_{2.5}$ recorded each year in the GMR_2 subregions. After four years of elevated maximums from 2000 to 2003, seven of the past eight years have seen the maximum measured 24-hour-average $PM_{2.5}$ concentrations return to levels closer to the advisory reporting standard for the daily average, except for 2009 which had the highest peaks ever recorded due to the September dust storms.

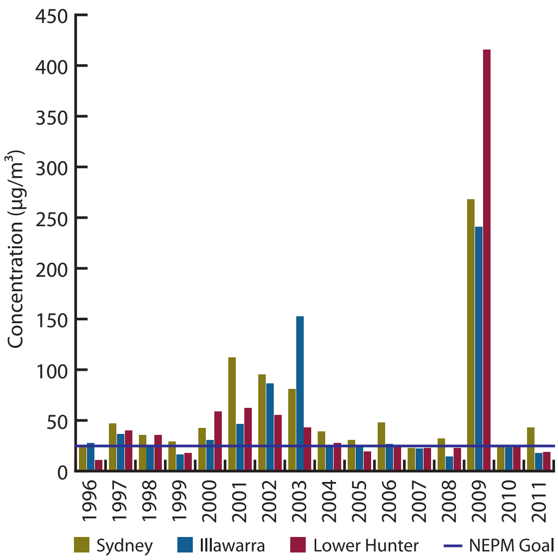
Other AAQ NEPM pollutants

NSW consistently complies with the national air quality standards for the other four criteria air pollutants under the AAQ NEPM – carbon monoxide, nitrogen dioxide, sulfur dioxide and lead. For details of the standards and past NSW performance against them, see 'Atmosphere 3.4: Metropolitan Air Quality' in *NSW State of the Environment* 2000 (EPA 2000).

Carbon monoxide is produced by the incomplete burning of fuels, with motor vehicles and industrial premises the main sources. In NSW, elevated levels of carbon monoxide are generally only encountered in areas with high traffic density and poor dispersion. Concentrations of carbon monoxide have fallen over the past 20 years as a result of changes to motor vehicle technology.

Nitrogen dioxide is predominantly produced by motor vehicles (as well as being a secondary pollutant). The AAQ NEPM standard was regularly exceeded in the winter months of the early 1980s. Measured concentrations have not exceeded the 1-hour-average standard since 1998; from 2002–07 the highest 1-hour value recorded in Sydney was only 75% of the standard. Over this period, maximum concentrations were lower still in the Illawarra and Lower Hunter regions.

Figure 2.9: Annual maximum 24-hour-average concentrations for particles ($PM_{2.5}$) in the GMR_2, 1996–2011



Source: EPA data 2012

Notes: ARS = advisory reporting standard. It is proposed that the ARS will become a full NEPM Standard.

Sulfur dioxide in GMR_2 originates mainly from industries such as metal processing, oil refining and coal-fired power generation. As a result of regulatory efforts, from 1994 to 2011 concentrations of sulfur dioxide have been low, with no exceedences recorded in the GMR_2. Maximum hourly ambient concentrations in Sydney were less than 25% of the AAQ NEPM standard. Higher concentrations are observed in the Illawarra and Lower Hunter regions as a result of industrial emissions, although these are also below the NEPM standard.

Lead concentrations, which were predominantly produced by motor vehicles, have fallen greatly due to changes in the formulation of fuel. Annual averages in Sydney have been consistently less than 20% of the AAQ NEPM standard for some time. With a complete ban on lead in petrol now in force, the primary source of lead in air at the regional scale has been eliminated. Consequently, routine monitoring of lead no longer became necessary and ceased in December 2004.

Air Toxics NEPM pollutants

The Air Toxics NEPM applies to five air toxics: benzene, toluene, xylenes, formaldehyde and benzo(α)pyrene (as a marker for polycyclic aromatic hydrocarbons). The NEPM is primarily concerned with the measurement of ambient levels of these five pollutants. The significance of monitored levels of the air toxics is assessed by comparing results against monitoring investigation levels (MILs). MIL values are the concentration of an air toxic which, if exceeded, requires further investigation and evaluation.

Between 1996 and 2001, the Ambient Air Quality Research Project investigated concentrations of 81 air toxics in four distinct groups: 17 dioxins (including furans); 41 volatile organic compounds (VOCs); 11 polycyclic aromatic hydrocarbons; and 12 heavy metals (EPA 2002). More than 1400 samples were collected at 25 sites. Three air toxics – benzene, 1,3-butadiene and benzo(α)pyrene – were identified as requiring ongoing assessment to ensure they remain at acceptable levels in the future.

An additional round of data collection commenced in October 2008 and concluded in October 2009. The five NEPM air toxics and additional VOCs were monitored at two sites in Sydney (Turrella and Rozelle) using a 1-day-in-6 cycle.

The Turrella site collected data on formaldehyde and acetaldehyde; 19 polycyclic aromatic hydrocarbons, including benzo(α)pyrene; and 41 VOCs, including benzene, toluene and xylenes. The Rozelle site collected data on formaldehyde and acetaldehyde, as well as 41 VOCs, including benzene, toluene and xylenes. NEPM-compliant sampling and analysis methods were used.

The monitoring results (NEPC 2010, Tables 1–5) clearly showed levels of air toxics were below the monitoring investigation levels. The air toxics monitored did not exceed the MILs at either location on any occasion. Benzo(α)pyrene levels of approximately 65% of the NEPM monitoring investigation level were the most significant.

It is important to note that, while there have not been any exceedences of the monitoring investigation levels, there can be occasions where incidents, such as equipment failure or fire, occur at premises that result in emissions of air toxics to the environment. These discharges can be harmful to human health and the environment. The *Protection of the Environment Operations Act 1997* (POEO Act) has provisions, such as environment protection licences and clean-up and prevention notices, to ensure regulated industry premises contain, minimise and clean up pollution where incidents like these occur.

Under the POEO Act, the EPA can also require licensed activities to undertake mandatory pollution reduction programs to further minimise their emissions to the atmosphere. A pollution reduction program may include, but is not limited to, requirements to carry out works for the purpose of preventing, controlling, abating or mitigating pollution.

Indoor air quality

The quality of indoor air depends on various parameters including:

- type of building materials used
- types of products used indoors (such as paint, electrical appliances, furniture and cleaning products)
- proximity to outdoor sources of air pollution
- types of indoor heating or cooling used
- cooking methods
- building ventilation rates
- particular uses of the building (including whether smoking occurs)
- daily, seasonal and climatic conditions.

Indoor air pollutants contain biological and chemical contaminants. Examples of the former include dust mites, mould spores and pet hair. Examples of the latter include contributions from combustion products and gases released from indoor materials (off-gassing emissions). In older buildings, dust from the roof cavity and lead from the disturbance of lead-based paints during renovations can be problematic or hazardous. Along with particulate matter, gases such as ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, airborne microorganisms and VOCs, and secondary (or 'environmental') smoke are the most common types of air pollutants encountered indoors.

Measured indoor air pollution

Monitoring in NSW homes has identified secondary tobacco smoke and emissions from solid-fuel heaters (such as woodheaters) and unflued gas heaters as important indoor sources that contribute to poor air quality. These are problematic as they raise concentrations of fine particles, carbon monoxide and nitrogen dioxide (Sheppeard et al. 2002; DEH 2004).

Additional pollutants and air toxics can also be released into the indoor and local outdoor environment where waste wood from demolition sites and renovations of old buildings is burnt in solid-fuel heaters. This material has often been treated with lead paint or chemicals used to preserve the wood to prevent termite or fungus attack or as a marine anti-fouling agent. Chemicals used to treat timber may contain such toxic substances as copper chrome arsenate (CCA) and pentachlorophenol (PCP). Importantly, it is illegal under the Protection of the Environment Operations (Clean Air) Regulation 2010 to burn any timber treated with CCA or PCP in NSW.

In 2003, pollutant monitoring undertaken in Sydney homes found that those using unflued gas heaters frequently had nitrogen dioxide concentrations exceeding the WHO 1-hour guideline of 0.11 parts per million: the guideline was exceeded at least once on 67% of house-days tested (DEH 2004). A small number of homes also exceeded health guidelines for other emission by-products of unflued gas heaters – carbon monoxide and formaldehyde.

The NSW Health Survey Program monitors health behaviours, health status, use of, and satisfaction with, health services and other factors that influence the health of NSW residents. Data on health-related behaviours and other risk factors from the surveys showed that unflued gas heaters remain the primary form of heating in about 18% of homes, while solid-fuel heating was used in around 15% (Centre for Epidemiology & Research 2008).

The NSW Health Survey also reported that 92.6% of adults aged 16 years and over lived in homes that were smoke-free in 2010 (up from 84.3% in 2004 and 69.8% in 1997) (Public Health Division 2000; Centre for Epidemiology & Research 2005; Centre for Epidemiology & Research 2010). The proportion of smoke-free family cars is also improving, with 86% of people aged 16 years and over saying they did not allow smoking in their vehicles (Centre for Epidemiology & Research 2010). Smoking when a child under 16 years is in the car has been illegal since 2009.

Pressures

From the status and trends it can be seen that the pollutants of *ongoing concern* for air quality in NSW are the main precursor pollutants for ozone (oxides of nitrogen and volatile organic compounds) and fine particles.

Major sources of pollutants

The most important human-related causes of air pollution are motor vehicle use, industrial activity and some domestic and commercial activities. Dust from the landscape, spray from the ocean, and the release of vapours from plants can also be significant contributors to poor air quality, along with bushfires and hazard reduction burns. Once in the atmosphere some pollutants undergo further chemical reactions and they can be transported by air movement across regions.

The 2008 Air Emissions Inventory for the Greater Metropolitan Region of NSW (EPA 2012) is a detailed listing of pollutants discharged into the atmosphere by source type at specific locations over a given time period (previous studies having been published in 1996 and 2007). The study area covered 57,330 square kilometres, which includes the greater Sydney, Newcastle and Wollongong regions, known collectively as the Greater Metropolitan Region (GMR_3). Approximately 76% of the NSW population resides in this region.

The inventory includes emissions from biogenic (natural living organisms), geogenic (natural non-living) and anthropogenic (human) sources as follows:

- natural (bushfires, wind-borne dust, marine aerosols and vegetation)
- commercial businesses (such as spray painters, printers, quarries and service stations)
- domestic activities (such as residential lawnmowing, portable fuel containers and woodheaters)

- industrial premises (such as coal mines, oil refineries and power stations)
- off-road vehicles and equipment (such as dump trucks, bulldozers and marine vessels)
- on-road transport (buses, cars and trucks).

The inventory covers over 850 substances, which include:

- common pollutants – ammonia, carbon monoxide (CO), lead, oxides of nitrogen (NO_x), particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2) and total volatile organic compounds (VOCs)
- organic compounds, such as 1,3-butadiene, benzene and formaldehyde
- metals, such as cadmium, manganese and nickel
- polycyclic aromatic compounds (PAHs), polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs)
- greenhouse gases – carbon dioxide, methane and nitrous oxide.

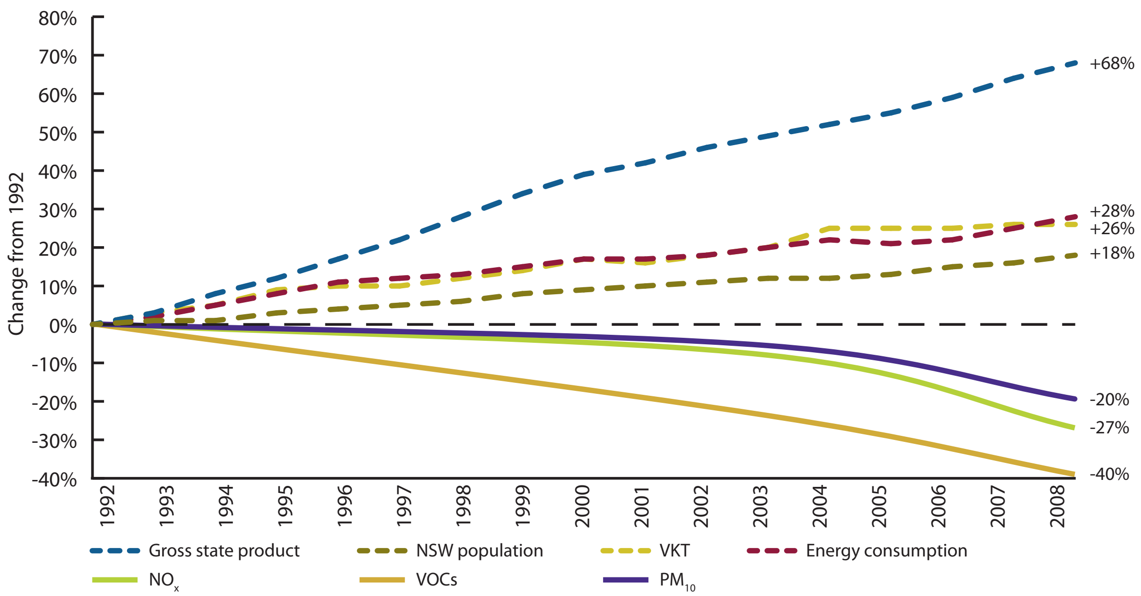
Figure 2.10 and **Figure 2.11** present trends in emissions for the Sydney region and GMR_3 compared with key NSW statistics. The inventory shows that, from 1992 to 2008, emissions have steadily decreased in the Sydney region (Figure 2.10), with NO_x decreasing by 27%, VOCs by 40% and PM_{10} by 20%. These declines occurred despite increases in key NSW statistics over the same period: gross state product up by 68%; vehicle kilometres travelled up 26% (see also People and the Environment 1.1); energy consumption (including electricity, petroleum, etc.) up 28%; and NSW population growth of 18%. The decrease seen in Sydney in NO_x and VOCs appears in part due to improved identification and control of emissions from industrial facilities.

In contrast to the Sydney region, emissions of NO_x steadily increased by 32% across the GMR_3 between 1992 and 2008, similar to the rate of increase in energy consumption which is mostly supplied from coal-fired power stations. Between 1992 and 2008, emissions of PM_{10} have risen increasingly quickly in the region by 48% overall, largely due to increased coal mining. Emissions of VOCs in the GMR_3 decreased overall by 6%, far less than the reduction that has occurred in Sydney.

Biogenic and geogenic sources are significant for several of the pollutants of ongoing concern. In 2008, 19.1% of PM_{10} emissions in Sydney were from natural sources, while 24.7% of VOC emissions had natural living and non-living sources. In contrast, only 1.7% of the oxides of nitrogen were from biogenic or geogenic sources.

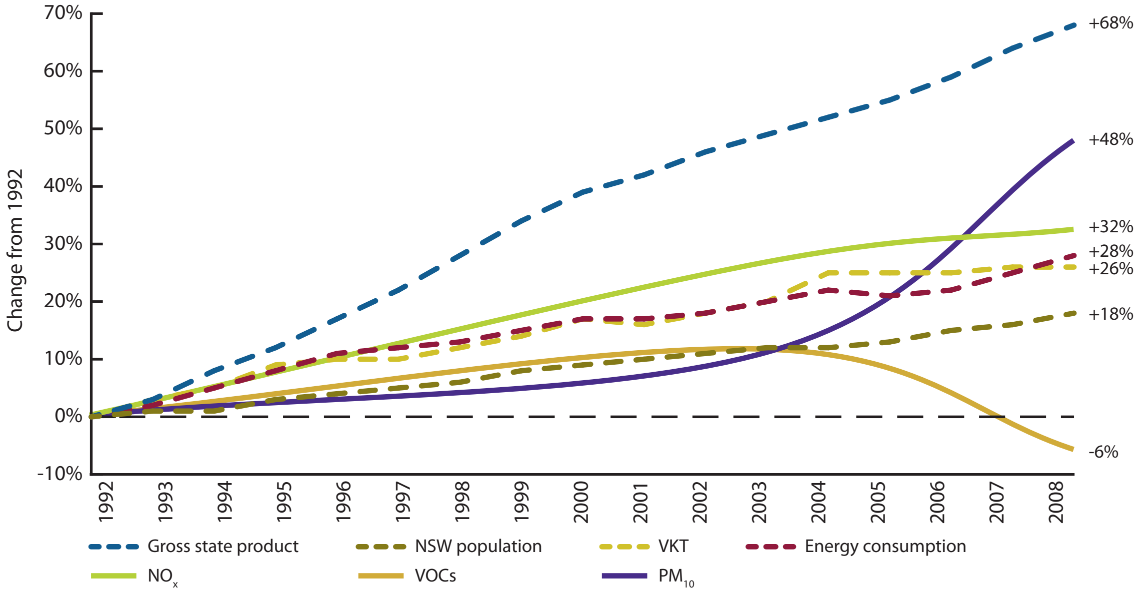
Figure 2.12 presents a detailed breakdown of anthropogenic air pollutant sources by sector and major activities in the Sydney region in 2008.

Figure 2.10: Trends in emissions in the Sydney region, compared with key NSW statistics



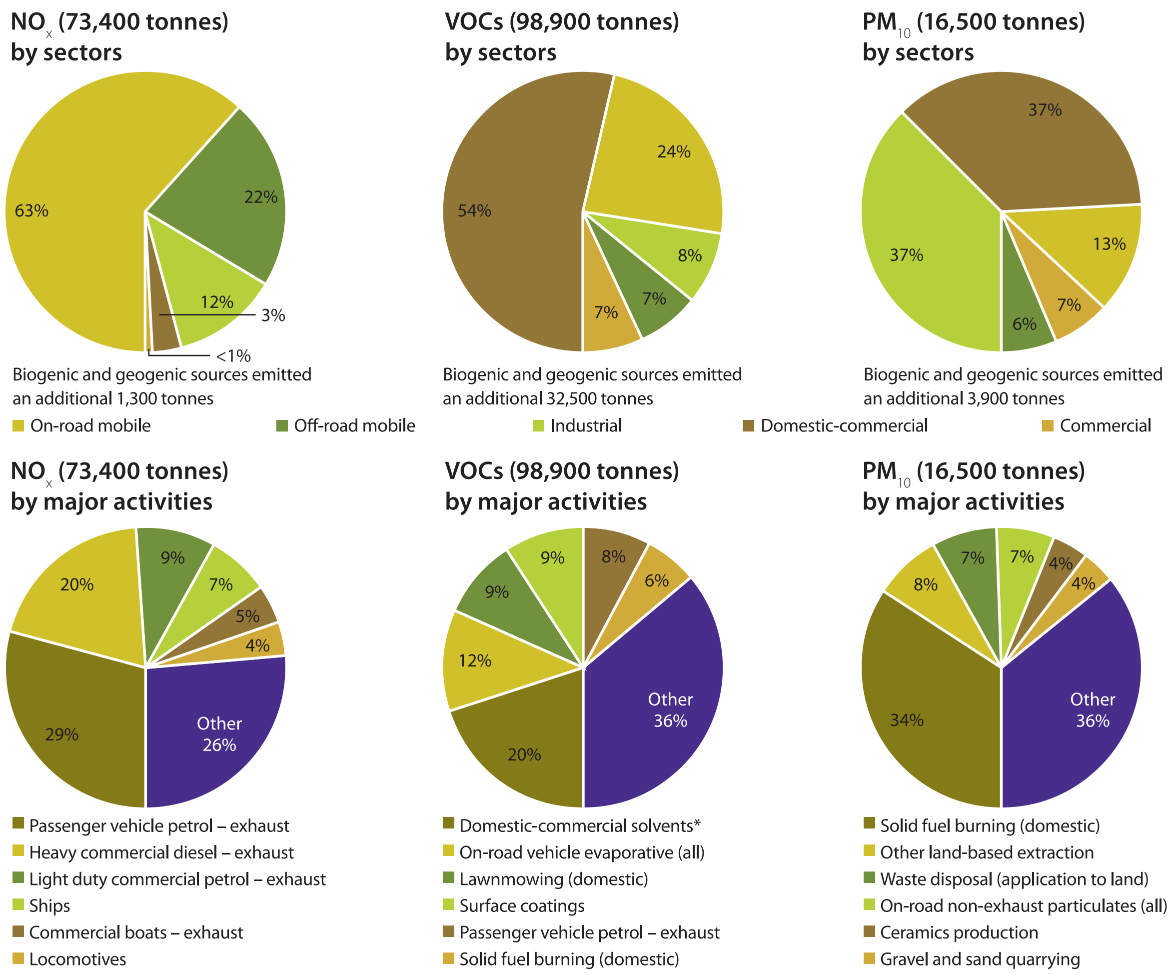
Source: ABS 2009; ABS 2010; ABARES 2011; BITRE 2011; EPA 2012

Figure 2.11: Trends in emissions in the GMR_3, compared with key NSW statistics



Source: ABS 2009; ABS 2010; ABARES 2011; BITRE 2011; EPA 2012

Figure 2.12: Detailed anthropogenic sources of NO_x, VOCs and PM_{10}, Sydney region, 2008



Source: EPA 2012

Notes: * 'Solvents' includes propellants and aerosols.

According to the 2008 Air Emissions Inventory (EPA 2012), on-road mobile sources are the largest source of NO_x emissions, contributing 63% of the total, while off-road mobile sources (such as construction and mining plant equipment) are the second largest single source at 22%. Major specific NO_x-producing activities were passenger vehicle petrol exhausts (29% of total emissions) and heavy duty commercial diesel exhausts (20%).

The largest single source of VOC emissions in Sydney (54%) is from the domestic-commercial sector, with on-road mobile sources such as the various evaporative emissions from both private and commercial vehicles contributing another 24% of the total. Domestic-commercial use of solvents and aerosols was the single largest major activity responsible for VOC emissions, contributing 20% of the total (or 23,500 tonnes).

The domestic-commercial and industrial sectors are the largest sources of PM_{10} emissions in the Sydney region, both contributing 37%. The single largest anthropogenic activity generating PM_{10} emissions was domestic solid-fuel heating, which accounted for 34% of the total (5700 tonnes), almost equalling all of the domestic-commercial emissions (6100 tonnes).

Reductions in emissions between 1992 and 2008 have largely resulted from the effectiveness of NSW Government regulation of industry, woodheater, fuel quality and motor vehicle standards. Any further improvements in emissions will require cost-effective programs targeted at unregulated sources since the contribution of emissions from these continues to grow. Unregulated sources typically include:

- aerosols and solvents
- surface coatings
- small engines, such as those used in lawnmowers and recreational boats
- off-road diesels, such as bulldozers, trucks and locomotives
- ships and port activities
- domestic woodheaters.

Air toxics

Air pollutant sources investigated by the 2008 Air Emissions Inventory (EPA 2012), such as commercial and industrial premises, are also often key sources of air toxics. The *Protection of the Environment Operations Act 1997* and regulations control toxic emissions to air from such premises.

Climate change pressures

Global emissions of greenhouse gases (see People and the Environment 1.2) will affect our climate and, in turn, this is likely to increase key air pollutants, such as ozone and particles. Climate change may influence the formation of ozone and secondary particles ($PM_{2.5}$) through elevated ambient temperatures and chemical changes in the atmosphere. There is ongoing investigation into the relationship between climate change and air quality (Cope et al. 2008; Jacob & Winner 2008; Walsh 2008).

Population pressures

Sydney's continued growth and expansion will have implications for air quality, requiring further action on transport emissions and the growing emissions from commercial, industrial and domestic sources. Increased development in western and south-western Sydney has the potential to expose more people to elevated ozone concentrations as the city's meteorology and topography cause these areas to be more affected by ozone pollution than coastal regions. Increased development at the interface with natural bushland also has the potential to increase exposure to the effects of smoke from bushfires and hazard reduction burns.

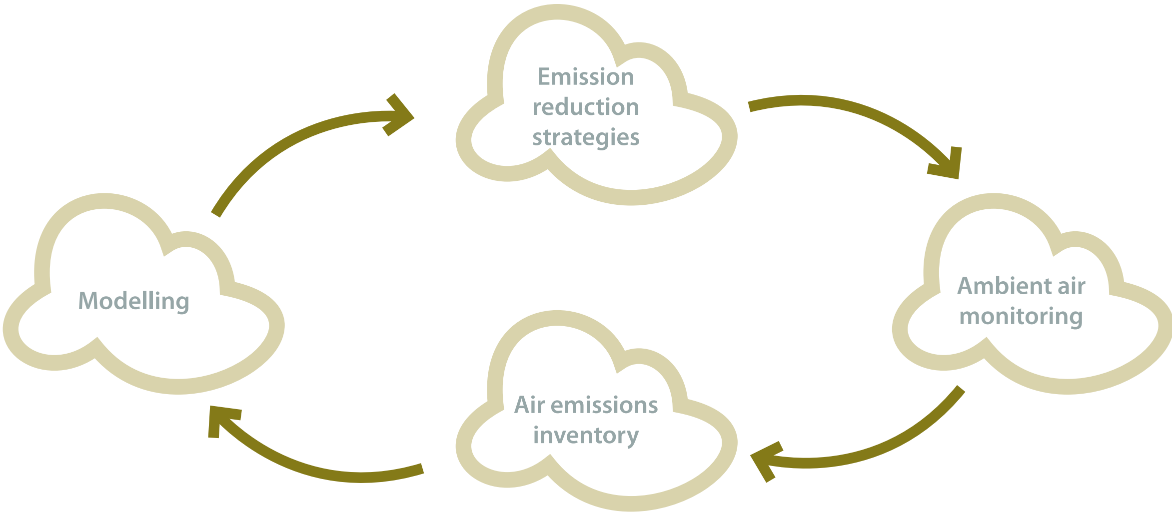
Responses

NSW 2021: A plan to make NSW number one (NSW Government 2011) recognises that clean air is important for the health of the NSW community and providing information on local air quality empowers local communities to engage in informed discussions on air quality.

Existing responses

An evidence-based approach is used to manage air quality in NSW (Figure 2.13). This approach uses a number of tools, including air quality monitoring, air emissions inventory studies, air quality modelling and economic analysis through updating information on the health impacts and costs of air pollution. The aim is to develop strategies and measures that deliver the greatest air quality improvements and health gains at a net benefit to the community.

Figure 2.13: Air quality management cycle



Controlling transport emissions: cleaner vehicles, fuels and engines

Transport is the main source of air pollution in Sydney. A number of key initiatives are being implemented to reduce emissions from motor vehicles by making fuels and vehicles cleaner, and encouraging people to use their cars less in favour of other transport options. These initiatives deliver significant health and liveability benefits.

Stage 1 vapour recovery (VR1): Capturing emissions of volatile organic compounds (VOCs) from underground storage tanks as they are filled by road tankers has been in place in most parts of Sydney for some time. More recently, this was extended to all parts of Sydney, as well as the Wollongong, Newcastle and Central Coast metropolitan areas.

Stage 2 vapour recovery (VR2): The next stage is to capture VOC emissions from vehicle petrol tanks during refuelling at petrol bowsers. VR2 has been introduced under the Protection of the Environment Operations (Clean Air) Regulation 2010 with vapour recovery equipment to be installed at the largest service stations in Sydney, Newcastle, Wollongong and the Central Coast by 2014 and at all but the smallest service stations in Sydney by 2017. Vapour recovery technology will reduce refuelling emissions by over 85% and its implementation will cut VOC emissions in the Greater Metropolitan Area (GMA) by 5000 tonnes per year by 2020 (about 1–2% of total VOC emissions in the GMA).

Summer petrol volatility: During the summer period – 15 November to 15 March – the volatility of petrol supplied in Sydney is limited to 62 kilopascals as a key means of managing the formation of ozone in Sydney. Petrol refiners, importers and blenders must test and report to the EPA on batch volatility.

Diesel Retrofit Program: Retrofitting existing diesel vehicles with exhaust treatment devices is a cost-effective strategy to reduce air pollutant emissions. This program involved the NSW Office of Environment and Heritage (OEH) and Roads and Maritime Services working in partnership with local councils and private enterprise to retrofit fleet vehicles. The program demonstrated that vehicle particle emissions could be reduced by around 46% for an average retrofit cost of $7600. At completion of the program in June 2011, over 520 vehicles from 71 fleets had been retrofitted. This delivered particle emission reductions of 4.7 tonnes per annum and will avoid approximately $1.05 million in health costs each year.

Clean Machine Program: The EPA is working with private and public organisations on a Clean Machine Pilot Program to reduce exhaust emissions from diesel plant and equipment used mainly in construction and industrial activities, such as cranes, dozers, loaders, graders, tractors and pumps. The program offers funding assistance for the installation of particle filters on older engines and advice on improved procurement and worksite practices. Nineteen organisations, including a number of local councils and private businesses, had joined the program as partners by June 2012 and more than 55 non-road diesel machines had been retrofitted. This will reduce diesel particle emissions in the GMR_2 by over 1.6 tonnes per year and avoid approximately $400,000 in annual health costs.

Controlling industry emissions

The *Protection of the Environment Operations Act 1997* (POEO Act), the POEO (Clean Air) Regulation and POEO (General) Regulation 2009 provide the framework for managing air pollution from major industry.

Strengthening industrial emission standards: Tighter industrial emission standards for oxides of nitrogen (NO_x), VOCs and particles were introduced when the POEO (Clean Air) Regulation was reviewed in 2005, along with a framework for the upgrade of old plant and equipment (see Parts 4 and 5 of the Regulation). Stage 1 of the framework required the phase-out by 1 January 2008 of plant and equipment installed before July 1979. An implementation program helped achieve compliance by older industrial premises, including some of the oldest and largest industrial facilities such as refineries and steel mills.

The NSW Government is continuing to work with industry to ensure continuous improvement in emission performance. The Regulation was remade in 2010 and the second stage of the program to upgrade old industrial plant and equipment as required by regulation implemented on 1 January 2012. It requires premises to upgrade old plant and equipment over a six-year lead-in period and further reduce emissions of particles and additional pollutants, including NO_x and air toxics.

Best practice measures for controlling emissions from coal mining: Awareness is growing about the impacts associated with particulate matter emissions from coal mining in NSW. In addition to maintaining a strong regulatory and compliance focus on mines, the NSW Government is continuing to encourage improved environmental performance with reference to best management practice. Recommendations from a report commissioned by OEH, *International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone Environmental 2011), are being implemented through the Dust Stop program. All operating coal mines in NSW are being progressively required to undertake site-specific best management practice reviews through pollution reduction programs attached to their environment protection licences. These will determine the best approach for reducing dust emissions at each mine with all practicable measures implemented through pollution reduction programs.

Reducing emissions of oxides of nitrogen from cogeneration: Cogeneration involves using waste energy from the production of electricity to provide either heating and/or cooling. Gas-fired cogeneration can be one of the most greenhouse-friendly forms of fossil fuel-generated electricity. However, cogeneration is also a source of NO_x which reacts with VOCs in the presence of sunlight to form ground-level ozone.

The *Interim DECC Nitrogen Oxide Policy for Cogeneration in Sydney and the Illawarra* (DECC 2009) sets out a policy framework for emissions from cogeneration proposals. One of the concepts introduced in the interim policy is best available techniques (BAT) emission performance. Following consultation with stakeholders, a NO_x emission standard that constitutes BAT for new cogeneration plant in Sydney and the Illawarra was released in November 2009. The BAT emission standard is for natural gas-fired reciprocating internal combustion engines, the most common technology used in cogeneration/trigeneration applications.

Reducing volatile organic compound emissions from the printing industry: The NSW Government has continued work over the past years to ensure reductions in VOC emissions from the printing industry. This project identified premises that were not employing adequate means to minimise their emissions. Industry enterprises are being encouraged to purchase and install new pollution control equipment. It is estimated that installation of the new control equipment will result in a reduction of approximately 1300 tonnes of VOC emissions each year.

Controlling commercial and domestic emissions

The NSW Government has implemented a number of policies focused on the domestic-commercial sector as it is a significant contributor to air pollution in the state.

Woodsmoke reduction program: Woodsmoke is the largest source of $PM_{2.5}$ and PM_{10} in the Sydney region. Woodsmoke also contains a number of other air pollutants, including carbon monoxide, NO_x and a range of organic compounds, some of which (for example benzo(α)pyrene) are toxic or carcinogenic.

Woodsmoke is an issue that is predominantly managed by local government. The NSW Government is working with local councils to develop a set of options to more effectively manage woodsmoke. Developing strategies aimed at reducing woodsmoke and educating local government and the community about better management of it will help address particle and air toxic emissions simultaneously. The Government is also advocating for improved standards for woodheater emissions at the national level, a development that will benefit all of the cooler regions of the country.

Woodsmoke control consultation strategy: In early 2011, the Government commissioned an economic assessment of a range of policy options for controlling smoke from domestic woodheaters in residential locations with potentially high population exposure to woodsmoke. The findings of the study (AECOM 2011) will feed into the development of further measures to control woodsmoke.

In 2011, a survey of NSW local councils sought input into potential management measures for woodsmoke control. Responses from councils indicated overall support for developing new measures to improve the existing woodsmoke management framework.

The next stage of the consultation will be to release a discussion paper outlining a set of preferred woodsmoke control options supported by economic analysis.

Woodheater compliance audits: A Government audit of manufacturers, wholesalers and suppliers of woodheaters in 2009–10 found that 40% of the 454 heaters audited did not meet the regulatory requirement to have a valid compliance plate attached to the appliance when offered for sale. All businesses responsible subsequently rectified their non-compliance. The POEO (Clean Air) Regulation requires all new woodheaters sold in NSW to have a compliance plate which specifies that the particular model has been tested in accordance with the Australian Standard and complies with the emission limit.

Local government training: In 2011, OEH and the Clean Air Society of Australia and New Zealand held workshops for council officers who manage issues such as woodsmoke, odour and building site dust. The workshops were based on OEH's web-based Local Government Air Quality Toolkit.

Assessment and control of air quality impacts from licensed activities: The NSW Government works to assess, provide advice and place control conditions on the development and operation of air quality impacts from activities licensed by the EPA under the POEO Act. The guiding principles of this assessment process are that:

- emissions are effectively controlled to levels that protect the environment, human health and amenity; reflect reasonably available technology and good environmental practice; and reflect proper and efficient operation
- emissions of pollutants that have serious health effects and no safe threshold or that bioaccumulate are minimised to the maximum extent practicable by best management practice
- it is important to reconcile the needs of all key stakeholders, including NSW Government, proponents, licensees and the public.

Controlling air toxics

The POEO Act is a key control on the emissions of air toxics. Concentrations are managed by the POEO (Clean Air) Regulation, which controls backyard burning and sets emission limits for air toxics from industrial facilities. The POEO Act has measures such as clean-up, prevention and prohibition notices to ensure regulated industrial premises contain, minimise and clean up toxic pollution if an incident occurs.

Under the Act, the EPA can also require pollution reduction programs as licence conditions for regulated industrial premises to further minimise their emissions to the atmosphere. A pollution reduction program may include, but is not limited to, requirements to carry out works to prevent, control, abate or mitigate pollution.

In addition, the Commonwealth *Fuel Quality Standards Act 2000* and the Fuel Quality Standards Regulations 2001, manage air toxics emissions from motor vehicles.

Managing indoor air quality

Tobacco smoke: The *Smoke-free Environment Act 2000* progressively introduced smoking bans in NSW restaurants, pubs and bars, cafes and cafeterias, shopping centres, malls and plazas, community centres, and the dining areas of hotels. This culminated in a total ban on smoking in enclosed public areas of licensed premises from July 2007. Following passage of the *Public Health (Tobacco) Act 2008*, smoking was banned in motor vehicles with any passengers under the age of 16.

Legionnaire's disease: The Public Health (Microbial Control) Regulation 2000 continues to be the main tool by which air and water quality is controlled in relation to Legionnaire's and other diseases.

Heating in homes and schools: In 2007, the Australian Environmental Health Committee (enHealth) released a review on the use of unflued gas heaters in the indoor environment. *The Health Effects of Unflued Gas Heater Use in Australia* (enHealth 2007) was developed to provide evidence to guide policy on regulating and managing unflued gas heaters in Australia and New Zealand. The document reviews data on the levels of pollutants produced by unflued heaters and summarises the evidence for any links between the use of these heaters and adverse health outcomes (based on a review of the scientific literature).

Since 1990, the NSW Government's Gas Heater Replacement Program has been progressively replacing old-style unflued heaters in NSW public schools with low-NO_x emission unflued heaters: over 80% of the approximately 51,000 heaters have now been replaced.

Home maintenance: Asbestos products, lead paint, and accumulated contaminated dusts from domestic, industrial and road sources can be unknowingly disturbed during home maintenance and renovations, releasing harmful fibres, heavy metals and toxins to the indoor environment. The DIY Safe website contains information about the hazards and risks that home renovators may face from a range of chemicals or materials, while the Asbestos Education Committee's Asbestos Awareness website has been developed to increase awareness of the asbestos products that home renovators may encounter.

Monitoring and reporting urban air quality

The air quality monitoring network comprises 20 sites located in Sydney, the Illawarra and Lower Hunter regions and four sites in regional NSW (which measure particles only). The network is currently being expanded with 14 new (industry-funded) stations beginning operation in the Upper Hunter region in 2011–12. All will measure particles as PM_{10} with three sites also measuring particles as $PM_{2.5}$ and two sites also measuring sulfur dioxide and nitrogen dioxide. This is in addition to the monitoring required to be done by industry as part of their environment protection licences.

Two new multi-parameter stations will also be established – on the Central Coast and at Camden – with instruments for measuring meteorology, ozone, sulfur dioxide, carbon monoxide, particles (PM_{10} and $PM_{2.5}$) and visibility. Construction is expected to commence following development approvals in June 2012. These two additional stations will bring to 40 the total number of full multi-parameter monitoring sites.

Improving presentation and communication of air quality data: The NSW Government's air quality information system was upgraded in 2008 to make it more flexible and accessible. This upgrade, in conjunction with an improved data acquisition and telemetry system allowing monitoring stations to be on-line continuously, resulted in a number of significant changes in how air quality data is reported and presented. These changes included:

- a revised Air Quality Index calculation, increasing from three to six the number of pollutants used and bringing it into line with calculations in other jurisdictions
- hourly updates of the Air Quality Index for each monitoring station and region, instead of twice daily
- improved accessibility and functionality for air quality pages on-line, including greater use of maps and increased access to data through dynamic queries of historical summary data
- six air pollution categories instead of three – very good, good, fair, poor, very poor and hazardous
- a subscription service (via SMS and email) to allow the community to receive various alerts, including health alerts due to high pollution and regular pollution forecasts.

Clean Air Forums: Every three years, NSW hosts broadly based public forums to encourage public input on air quality trends and strategies. Clean Air Forums were held in 2001, 2004, 2007 and 2010. The theme of the most recent forum was 'Future-focused technologies to reduce greenhouse gas emissions and improve air quality'. The forum brought together over 200 representatives from the community, local councils, scientists, students, environment and transport advocates, and government to discuss ideas and showcase cutting-edge technologies that can help reduce greenhouse gases and air pollution.

Let's Clear the Air: The OEH air education support project 'Let's Clear the Air' commenced in 2009. This is a public environmental education and community awareness project promoting greater community understanding of air pollution and its impacts and encouraging the adoption of sustainable behaviours by individuals and businesses to help improve air quality in metropolitan and regional NSW. The project developed a range of education resources to increase local-level community support for initiatives under the Clean Air, Healthy Communities Program (CAHC) and included workshops and grant funding for local councils. CAHC was an initiative funded by the NSW Environmental Trust to reduce vehicle emissions, improve vehicle efficiencies and reduce dependence on cars with multiple benefits for public health, greenhouse gas emission, local air quality and the community. CAHC received $5 million in funding from the Environmental Trust over four years (2007–08 to 2010–11).

To help local councils deliver air education programs in their communities, the Let's Clear the Air website provides information and free awareness-raising and educational resources. The education projects promote simple actions to improve air quality for issues ranging from reducing woodsmoke to training in enviro-driving practices and encouraging commuters to use sustainable transport.

Grant funding was made available to councils to run local demonstration projects to further encourage people to improve local air quality. A total of $272,000 in funding was distributed to such councils as Armidale, Griffith, Lake Macquarie, Maitland, Parramatta and Willoughby.

Other supporting strategies

Rural particles: There are a number of potential contributors to the exceedences of the AAQ NEPM standard for PM_{10} in some regional centres, including dust storms, agricultural burning, woodsmoke and bushfires. The NSW Government is working with local government and local communities to develop a rural particles strategy. The strategy will focus on increasing our knowledge about the relative contribution of different sources to the exceedences of the PM_{10} standard through a pilot project in Wagga Wagga with the EH Graham Centre and local stakeholders. This urban centre was chosen because of the high number of exceedences of the standard between 2002 and 2010 (although there have been none since the end of the drought in mid-2010).

The primary objectives of the strategy are to:

- identify particle sources
- collate and analyse existing information about particle emissions from rural activities
- identify opportunities for cost-effectively reducing rural particle emissions through conservation farming and new technology, bushfire and hazard reduction burning controls, and general dust control
- develop priority management actions in collaboration with other government agencies, local communities and key agricultural stakeholders
- engage with the community to reduce pollution.

National responses

Many significant actions on air pollution can only be pursued at a national level. Emissions from the commercial and domestic sectors are growing, increasing their relative contribution to overall emissions. NSW will continue to work with other governments to develop appropriate controls at a national level. This includes product standards for woodheaters, non-road diesel engines and equipment such as lawnmowers, which cannot be enforced by the states due to Mutual Recognition Agreements between them and the Commonwealth.

National Indoor Air Project: The Australian Department of Sustainability, Environment, Water, Population and Communities has been examining indoor air issues, in consultation with health agencies. The aim is to assess whether there are grounds for a national response to Australia's indoor air problems. Under the Indoor Air Project, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) was commissioned to study the levels of major indoor air pollutants inside the average Australian home, including looking at influences such as proximity to major roads (CAWCR 2010a; CAWCR 2010b).

The CSIRO study investigated:

- What is the indoor air quality of a typical Australian dwelling (using 40 homes across Melbourne)?
- What is the effect of busy roads on indoor air quality of a typical Australian dwelling?
- What is the effect of building construction, materials and activities on the indoor air quality of a typical Australian dwelling?

Pollutants investigated included carbon monoxide and carbon dioxide; PM_{10} and $PM_{2.5}$; carbonyl; VOCs; nitrogen dioxide and ozone; nicotine; fungi and bacteria; persistent organic pollutants (such as brominated fire retardants, phthalates, polychlorinated biphenyls, perflourates and pesticides); and heavy metals (mercury, cadmium, nickel and lead).

It was found that the specific air pollutants investigated were at concentrations that were either lower than or comparable with the concentrations observed in previous studies in Australia. Most were also found to be at concentrations tens to hundreds of times lower than those observed in cities overseas such as New York and Kyoto. Lead was an exception, with a significant minority of samples near to or exceeding guidelines, especially in buildings over 40 years of age. Mercury concentrations were also higher in the older buildings.

Older and well-ventilated buildings tended to have lower concentrations of pollutants. Dwellings with an internally accessed garage have significantly higher PM_{10} and VOC concentrations. However proximity to busy roads had a fairly limited impact on the levels of these pollutants in indoor air.

Building rating schemes: The National Australian Built Environment Rating System (NABERS) is a NSW program that has been extended nationally and rates buildings on the basis of their measured environmental impacts (see also People and the Environment 1.4 and People and the Environment 1.5). NABERS Indoor Environment ratings are available for offices. OEH is working with the NSW Department of Education and Communities to develop a rating for NSW schools and with NSW Health to rate public hospitals. In 2010–11, 12 NABERS Indoor Environment ratings were certified. Close to 600 businesses are engaging with NABERS to rate their premises.

In 2003, the Green Building Council of Australia introduced Green Star, a voluntary environmental rating system which evaluates the performance of a building at the design stage.

Developing responses

State

Supporting climate change strategies: There are important links between activities that emit air pollutants and those that create greenhouse gas emissions:

- Air pollutants and greenhouse gases are often emitted by the same sources, such as fuel combustion.
- Technical measures to reduce greenhouse gas emissions may have a similar impact on emissions of air pollutants, and vice versa.
- Some pollutants, such as NO_x in the formation of ozone, contribute to both regional air pollution and climate change.
- 'Black carbon' – an air pollutant which is the product of the incomplete combustion of wood fires, biomass and diesel fuels – warms the planet by absorbing heat in the atmosphere and reducing albedo, the ability of snow and ice to reflect sunlight. In recent years, science has detected an increase in direct 'radiative forcing' due to black carbon, which exacerbates the greenhouse effect. Radiative forcing relates to the capacity of an agent, such as carbon black, to alter the balance of incoming and outgoing energy in the Earth's atmosphere and is an index of the importance of the agent as a potential climate change mechanism.
- Air pollution and climate change may have an effect on each other: for example, climate change influences the formation of ozone and secondary particles ($PM_{2.5}$) through chemical changes in the atmosphere, while an increase in background ozone and particle concentrations contributes to climate change.

Links can be made between policy responses to both issues. An example is the transport and energy sectors: both are key sources of greenhouse gases, NO_x and VOCs, and policies to reduce the impacts of one problem can also have significant benefits for the other (see also responses in People and the Environment 1.1, People and the Environment 1.2 and People and the Environment 1.5). In contrast, actions to reduce some pollutants may create possible global warming: for example, reducing fine particles can lower pathways for CO_2 absorption or reflecting incoming solar heat.

Heating in homes and schools: The Government commissioned research by the Woolcock Institute of Medical Research to investigate the possible health risks that may arise from the use of low-emission unflued gas heaters in government schools (Marks et al. 2010). The reports recommended that the heating chosen should avoid adverse effects on health but at the same time be effective and efficient and have a sound environmental profile. Options for alternative sources of heating in government schools are being investigated.

Interjurisdictional

As many significant actions on air pollution can only be pursued at a national level, NSW is working with other jurisdictions to develop a National Plan for Clean Air. This aims to integrate the setting of air quality standards with actions to reduce air pollution (including from unregulated sources) that both improves the health of people who live in NSW and reduces costs to the state's healthcare system.

As part of the plan, an exposure reduction framework for particles is being considered. The rationale for this approach lies in the limitations of traditional air quality compliance standards to account for exposed populations and encourage further air quality improvement once standards have been met. The exposure reduction framework would seek to drive continued improvements in particle levels and emissions, as well as exposure reduction actions that would maximise net benefits to society.

NSW is advocating that the plan include national actions and standards to reduce emissions such as those from diesel engines, boat engines, garden equipment and domestic woodheaters. The National Plan for Clean Air provides an opportunity to progress these measures. Similarly, NSW has supported the introduction of tighter national vehicle and fuel standards at the Commonwealth level as a key element in reducing urban air pollution. The plan is likely to consider strategies to reduce VOC emissions as part of examining the impacts of ozone. This could include emissions from surface coatings, aerosols and solvents, which have an impact on indoor air quality.

Cleaner vehicles, fuels and engines: In June 2011, the Commonwealth announced the timetable for the introduction into Australia of Euro 5 and Euro 6 standards for light vehicles (all new cars, four-wheel drives and utilities) (*Regulation (EC) No. 715/2007 of the European Parliament*). Euro 5 standards will be introduced in two stages, with any new model vehicles produced from 1 November 2013 required to meet them. All new vehicles will be required to comply with the Euro 5 standards by 1 November 2016, regardless of when they were first produced. All new models introduced from 1 July 2017 will need to comply with the Euro 6 standard and, by 1 July 2018, all new light vehicles sold in Australia will also need to meet the higher standard.

Future opportunities

Building codes and standards: There is growing interest in the potential to control areas such as building construction materials and management of indoor air quality at the design stage (such as via new building code rules). In 2004, the Australian Building Codes Board recommended that future building codes include sustainability criteria towards these ends (ABCB 2004), but new building code rules have not yet been implemented. Emissions from domestic appliances and surfaces, furnishings and consumer products are also areas of potential investigation.

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