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Climate Change Blueprints

Climate Change, Air Pollution and Health in Australia

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Grand Challenge on Climate Change
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Preface

Increasing greenhouse gas emissions are on track to interfere with our climate system in dangerous and costly ways. Over the coming decades, we will experience worsening heat waves, increased severity of floods and storms, harsher bushfire seasons and rising sea-levels. But it's not just the health of our planet that will be affected; human health will also be impacted in significant and detrimental ways. For example, the risks of poor health and death due to heat stress, malnutrition, and food- and water-borne diseases are all expected to rise. Vector-borne diseases such as malaria are also expected to become more widespread as global temperatures rise and humidity increases. Food will be harder to grow and freshwater supply will become scarcer in some regions. Large scale migration of displaced populations will further place a severe burden on human health in affected communities. War, famine, and disease could become far more widespread, at a time when adapting to climate change will be costly and challenging.

While attention is often placed on the impact of today's greenhouse gas emissions on our future, the burning of fossil fuels and emissions of other climate altering pollutants are already having a deleterious impact on human health. For example, global warming has increased the risk of heat-related death and illness, and regional temperature and rainfall changes have reduced food production in some regions. But perhaps the most under-appreciated aspect of climate change and human health is the interplay between greenhouse gas emissions, climatic changes, and air pollution.

This report, *Climate Change, Air Pollution and Health in Australia*, is one of three Climate Change Blueprints launched in November 2017. The report was compiled by leading experts in the field and produced under the auspices of the UNSW Grand Challenges program. The UNSW Grand Challenges program, an initiative introduced in the UNSW 2025 Strategy, aims to address the biggest issues facing humanity. The program leads the debate and facilitates critical discussions and actions with researchers, government, policymakers, business and the wider community; on areas such as refugees and migration, inequality, technology in the 21st century, and climate change.

Since its inception in 2015, the UNSW Grand Challenge on Climate Change has hosted lectures, events, and facilitated discussions on topics ranging from impacts and security to intergenerational consequences and adaptation. These Climate Change Blueprints represent a major effort to inform the community of the challenges and opportunities facing society in the areas of energy, human health, and justice.

The aim of this blueprint is to set out the necessary actions to minimise the risk of climate change and air pollution to human health in Australia. This blueprint includes several areas of co-benefit wherein tackling climate change will also lead to improved human health. Front and centre in this is the benefit to society of cleaner air; namely, by addressing greenhouse gas emissions and limiting air pollution, human health will be significantly improved. A win-win for all.

I commend the *Climate Change, Air Pollution and Health in Australia* blueprint as a seminal report outlining the ways we need to tackle the interrelated problems of climate change and air pollution for the betterment of human health. Via stronger air pollution regulations, a decarbonised energy sector, and redesigned cities that optimise healthy living in a warming climate, we can mitigate some of the worst impacts of climate change on human health.

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Executive Summary

The world is warming. Since the Industrial Revolution the burning of fossil fuels – coal, oil and gas – has increased carbon dioxide levels in the atmosphere, this rise driving climate change.

Burning fossil fuels not only drives changes to the world's climate, it also has a significant, and growing, impact on human health. In Australia, this is less acknowledged by governments, the media and, therefore, the general public than the problem warrants. This Blueprint explains the problem and outlines four goals for action.

In Australia, air pollution from burning fossil fuels and from industrial processes causes about 3,000 premature deaths a year. That's eight premature deaths a day, a figure almost three times the national road toll. Changes in atmospheric temperatures and conditions due to climate change will increase that death rate.

AIR POLLUTION IS ALREADY A SIGNIFICANT HEALTH PROBLEM IN AUSTRALIA, AND ON CURRENT TRENDS WILL WORSEN IN THE FUTURE. THE ESTIMATED FINANCIAL COST OF PREMATURE DEATHS DUE TO AIR POLLUTION RANGES FROM ROUGHLY $11 BILLION TO $24 BILLION PER YEAR.

Climate change and air quality are interconnected in three main ways:

1. Climate change has the potential to increase certain air pollutants. For example, atmospheric warming may increase ground level ozone, an air pollutant damaging to human health.
2. Emissions of air pollutants can also influence the climate. Ozone and black soot particles, for instance, have a warming effect on the climate, while some aerosols have a cooling effect by blocking out sunlight.
3. Many sources of air pollution are also important sources of greenhouse gas emissions, which are responsible for trapping heat in the atmosphere, causing climate change. The energy sector, including both combustion of coal for power generation and of diesel and petrol in motor vehicles, is responsible for two-thirds of greenhouse gas emissions in Australia. Inefficient combustion of carbon-containing materials is the main source of many air pollutants including fine particulates which are particularly damaging to health.

Air pollution is already a significant health problem in Australia, and on current trends will worsen in the future. The estimated financial cost of premature deaths due to air pollution ranges from roughly $11 billion to $24 billion per year.

Many factors contributing to poor air quality are likely to increase in the future. Energy use is projected to increase. If this comes from burning fossil fuels, it will cause an increase in air pollution and greenhouse gas emissions. According to the current emissions-growth trajectory, Australia will not meet its emissions reduction targets for 2030, committed to as part of the global Paris Agreement on climate change in 2015.

Climate change will also worsen this century, causing an increase in extreme weather events such as heatwaves, and an increase in bushfires with their associated health impacts. Simultaneously, the population is increasing, ageing and becoming more urban. This means that in the future, greater numbers of people will be exposed to poor air quality, including vulnerable groups, such as the elderly, and those with chronic respiratory illness. Combined, these factors will have significant detrimental and interconnected synergistic health impacts.

Action is urgently required. Australia's greenhouse gas emissions must be cut as part of global action to tackle climate change. Cuts are also needed to improve air quality and address the growing health problem.

This Blueprint suggests four goals with associated policy actions. These four goals and recommendations are themselves interconnected. Acting on one will have benefits for the others.

1. **Strengthen air pollution regulations.**
    - Establish a *National Air Pollution Prevention Act*.
    - Develop a national air pollution exposure reduction framework.
    - Legislate binding national emissions limits.
    - Establish a national load-based licensing scheme with fees that fully account for the externalities of air pollution.
    - Expand state government inspections of industries and increase penalties for industries that breach their licence conditions.
    - Clean up emissions from coal-fired power stations with best practice pollution reduction technologies.
2. **Commit to 100 per cent renewable energy by 2050.**
    - Set a binding national emissions reduction target to reach net zero carbon dioxide emissions by 2050.
    - Extend the Renewable Energy Target to 2040.
    - Put a price on carbon dioxide and set an increasing trajectory for this price.
    - Provide incentives to consumers to support the broad-scale adoption of electric vehicles and invest in infrastructure for electric vehicles.
    - Build a high-speed rail link between east coast cities and major regional areas.
3. **Promote sustainable, liveable cities.**
    - Develop regional and suburban mini-cities which provide opportunities for people to work and play closer to home.
    - Transform building stock to net zero emissions.
    - Promote active modes of transport, such as walking and cycling.
    - Deliver more public transport services with improved access.
    - Set ambitious targets for urban greening to create cooler microclimates and improve air quality in urban areas.
4. **Manage health risks resulting from poor air quality.**
    - Assess the risk of asthma epidemics and improve early warning systems.
    - Develop air quality forecasting tools to plan hazard reduction burns.
    - Increase monitoring of air pollution focusing on known pollution hotspots.
    - Establish a National Air Quality Data Service.
    - Run a public health campaign to inform people on how to reduce their personal contribution and exposure to air pollution and climate change.

In the process of addressing health problems due to air pollution, implementing the actions outlined in this Blueprint would help tackle climate change, energy insecurity and unsustainable urban planning. To cater for the projected growth in population and urbanisation in the coming decades, major investments in our energy systems and urban infrastructure will be required.

It is critical that we consider the impacts on future air quality from decisions made today about energy systems and urban planning. It is essential to ensure investments set the nation up for a healthy future, instead of locking it into an unhealthy one. On health and air quality grounds alone, new coal-fired power stations should not be built, the life of existing ones should not be extended, and new freeways should not be constructed.

It is possible to tackle the problems of air pollution, climate change and energy security simultaneously by implementing smarter energy policies, ones that deliver health and economic co-benefits. If actions are taken now to reduce air pollution and greenhouse gas emissions, the burden of air pollution on human health and the economy can be significantly reduced.

ACTION IS URGENTLY REQUIRED. AUSTRALIA'S GREENHOUSE EMISSIONS MUST BE CUT AS PART OF GLOBAL ACTION TO TACKLE CLIMATE CHANGE.

How are climate change, air pollution and health interrelated?

Climate change impacts human health in a range of ways, both directly and indirectly. The direct health effects include deaths, illnesses, injuries, and mental trauma caused by an increase in the frequency and intensity of extreme weather events such as heatwaves, bushfires, floods, storms and cyclones.

Climate change is projected to cause an increase in the number of hot days and heatwaves.[1] Combined with changes in population demographics, heatwave-related deaths are projected to more than double over the next forty years.[2]

Climate change also influences health indirectly. For example, climate change is projected to cause a change in the distribution and transmission of certain infectious diseases across Australia. Other indirect health effects include impacts on food and water security, and on levels of conflict. The impacts of climate change on air quality through increasing airborne allergens (aeroallergens), and ambient air pollution are an indirect effect of climate change on health.

The impact of climate change on air quality and health is potentially significant, yet in Australia, this area has received comparatively little attention compared to studies investigating the health effects of climate change in relation to heatwaves and infectious diseases. The issues of air quality and climate change are, however, tightly linked. As the main sources of air pollution are also the main sources of greenhouse gas emissions, mitigating climate change will deliver a range of health co-benefits.

Which components of air quality are relevant to health?

Air quality is influenced by many factors, the most important being emissions of air pollutants, local weather conditions and topography.

The main cause of poor air quality is the emission of primary air pollutants. Secondary pollutants are formed when primary air pollutants, emitted directly from a source, then react chemically in the air. The source of pollution, the local topography and the meteorological conditions all affect the rate of air pollution dispersal. For example, factors such as wind speed and direction, humidity, temperature and precipitation affect how quickly air pollutants disperse.

Air pollution can come from both natural and anthropogenic (human-made) sources. Natural sources include dust, salt spray from the oceans, volcanic eruptions and bushfires. Anthropogenic sources include emissions from power stations, factories, motor vehicles and hazard reduction burns. While little can be done to reduce those natural sources of air pollution, it is possible to control and reduce anthropogenic sources.

The most common air pollutants damaging to human health in Australia are: fine and coarse particulate matter; gases such as nitrogen dioxide, sulphur dioxide, ozone, and carbon monoxide; along with airborne lead and a class of pollutants called air toxics. Fine and ultrafine particulate matter has in recent years been recognised by medical science to be particularly damaging to human health. Although Australia has made significant progress over recent decades in reducing some types of pollutants, levels of coarse and fine particulate matter and ground level ozone still regularly exceed national standards.

What are the health impacts of air pollution?

Air pollution is responsible for causing 3,056 premature Australian deaths each year, according to one major study.[3] This represents 2.3 per cent of total deaths in Australia per year – more than the number of deaths from car accidents on our roads. The main causes of death attributable to air pollution exposure are ischaemic heart disease (959), stroke (432), lung cancer (351) and chronic obstructive pulmonary disease (184). The number of healthy life years lost each year due to these premature deaths is calculated to be 27,519.[4]

Air pollution also significantly diminishes the quality of life for people suffering chronic respiratory disease. Approximately 1 in every 9 Australians – around 2.5 million people – suffer from chronic asthma.[5] In 2014-15, there were 39,415 reported hospitalisations where asthma was the main diagnosis, and 419 deaths caused by asthma.

The detrimental health effects of air pollution range from irritation of the airways to premature death from a range of causes. Older people, children and people with pre-existing health conditions are most vulnerable to air pollution.

The link between exposure to air pollution and cardiovascular and respiratory conditions is well established. The carcinogenic effects of air pollution have also been increasingly recognised in recent years.[6] [7] Health effects can arise from both long-term cumulative exposure and short-term acute exposure.

1 Bureau of Meteorology and CSIRO. (2014). State of the Climate Report. Australian Government, Canberra, ACT, Australia.
2 Department of Infrastructure and Transport. (2013). State of Australian Cities 2013. Australian Government, Canberra, ACT, Australia.
3 Begg S, Vos T, Barker B, Stevenson C, Stanley L & Lopez A. (2007). The burden of disease and injury in Australia 2003. Cat. no. PHE 82. Canberra: Australia Institute of Health and Welfare. Available: http://www.aihw.gov.au/publication-detail/?id=6442467990 [Accessed 25 June 2017].
4 Ibid (2007)
5 Asthma Australia. (2017). Statistics. Available: https://www.asthmaaustralia.org.au/nsw/about-asthma/what-is-asthma-/statistics [Accessed 10 June 2017].
6 Raaschou-Nielsen O, Andersen ZJ, Beelen R, et al. (2013). Air pollution and lung cancer incidence in 17 European cohorts: prospective analyses from the European Study of Cohorts for Air Pollution Effects (ESCAPE). *Lancet Oncology*, 14 (9): 813–22.
7 Krewski D, Jerrett M, Burnett RT, et al. (2009). Extended follow-up and spatial analysis of the American Cancer Society study linking particulate air pollution and mortality. *Research Report (Health Effects Institute)*, 140: 5–114.

Bronte beach during the Sydney dust storm, 23 September 2009. Credit: Donna Green

THE DETRIMENTAL HEALTH EFFECTS OF AIR POLLUTION RANGE FROM IRRITATION OF THE AIRWAYS TO PREMATURE DEATH FROM A RANGE OF CAUSES. OLDER PEOPLE, CHILDREN AND PEOPLE WITH PRE-EXISTING HEALTH CONDITIONS ARE MOST VULNERABLE TO AIR POLLUTION.

Particulate matter comprises coarse particles (PM10), fine particles (PM2.5) and ultrafine particles (PM1). Coarse particles approximately the width of a human hair, are small enough to lodge in the lungs, precipitating or exacerbating a range of cardiovascular and respiratory illnesses. Fine particles are even more damaging to health than coarse particles because they can enter the bloodstream while ultrafine particles are believed to have the most serious adverse health impacts compared with both classes of larger particles.

Ground level ozone can cause throat and eye irritation, respiratory and cardiovascular diseases and premature death. Nitrogen dioxide is another respiratory irritant that can trigger asthma, respiratory tract infections and irritation of the bronchi. It has also been associated with heart disease. Other health impacts of these gases include eye irritation and exacerbation of symptoms to common aeroallergens.[8]

Exposure to carbon monoxide decreases the amount of oxygen that can be carried around the body in the blood stream seriously compromising organ function. Carbon monoxide at high concentrations (for instance that caused by bushfires) is lethal.

What are the costs of air pollution to the economy?

The health costs from air pollution in Australia are significant. The annual financial cost is estimated to be in the order of $11.1 billion to $24.3 billion.[9] [10] The cost of asthma alone is estimated to be $655 million, that is 0.9 per cent of total direct government spending on health. The OECD has estimated that the economic cost of Australian motor vehicle emissions was about $5.8 billion in 2010, up from $2.9 billion just five years earlier.[11] The combined externalities of air pollution and carbon dioxide emissions from coal-fired power generation are estimated to be $42/MWh for black coal, $52/MWh for brown coal, and $19/MWh for gas.[12]

8 Tunnicliffe et al. (1994). Effect of domestic concentrations of nitrogen dioxide on responses to inhaled allergen in asthmatic patients. *The Lancet*, 344: 1733-36.

9 Begg S, Vos T, Barker B, Stevenson C, Stanley L and Lopez A (2007) The burden of disease and injury in Australia 2003. Cat. no. PHE 82. Australian Institute of Health and Welfare, Canberra. Available: http://www.aihw.gov.au/publication-detail/?id=6442467990 [Accessed 25 June 2017]

10 Access Economics. (2008). The Health of Nations: The Value of a Statistical Life. Report for the Office of the Australian Safety and Compensation Council. Available: http://www.safeworkaustralia.gov.au/sites/swa/about/publications/Documents/330/TheHealthOfNations_ Value_StatisticalLife_2008_PDF.pdf [Accessed 21 Sept 2017].

11 Organisation for Economic Cooperation and Development (OECD). (2014). The Cost of Air Pollution: Health Impacts of Road Transport. Available: https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=6&cad=rja&uact=8&ved=0ahUKEwjJ2Yun1rTWAhUFqJQKHc_MDx0QFghKMAU&url=http%3A%2F%2Fwww.sviva.gov.il%2Fenglish%2Fenv_topics%2Fairquality%2Fpollutionfromtransportation%2Fdocuments%2Fthe-cost-of-air-pollution-oecd-report-2014.pdf&usg=AFQjCNHTDa5xCx-Sbw95suaqHd8BsKiQ-g [Accessed 21 Sept 2017].

12 Australian Academy of Technological Sciences and Engineering (ATSE). (2009). The Hidden Costs of Electricity: Externalities of Power Generation in Australia. Available: https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjD--a32LTWAhULUbwKHd6QBysQFggoMAA&url=https%3A%2F%2Fwww.atse.org.au%2FDocuments%2FPublications%2FReports%2FEnergy%2FATSE%2520Hidden%2520Costs%2520Electricity%25202009.pdf&usg=AFQjCNHRuB5DFQwj6Pi9iNMPqOnt55z2xA

How does climate change threaten future air quality?

Climate change will reduce future air quality. Climate change alters meteorological variables that influence the development, chemical transformation, transport, dispersion and deposition of air pollutants. Two pollutants particularly influenced by climate change are ground level ozone and particulate matter. Climate change will also affect air quality by increasing the frequency and severity of bushfires and dust storms, and modifying aeroallergens.

Ground level ozone

Ground level ozone is directly influenced by climate change. This gas is formed by an atmospheric chemical reaction between sunlight and a number of precursor pollutants including oxides of nitrogen, methane, volatile organic compounds and carbon monoxide. In most regions around the world, including Australia, where temperature is projected to increase, ground level ozone will, therefore, also increase, especially in places with high levels of existing precursor pollutants.

The increase will cause a rise in associated mortality. For example, implementing maximum feasible greenhouse gas emission reductions – using currently available technology – compared to a future scenario where little is done to curb emissions, could avoid 5,600 premature ozone exposure deaths annually from 2030 onwards in Australia and Japan.[13]

Particulate matter

The influence of climate change on particulate matter is more complex and less direct than its influence on ground level ozone. Particulate matter comprises many different components, some released directly from the source (primary particulate matter) and some in the air through chemical reactions (secondary particulate matter).

Components of particulate matter are influenced by meteorological variables in different ways. Those most influential are precipitation frequency and mixing depth (the vertical extent of the atmosphere where convection and turbulence cause air pollutants to mix and disperse).

More frequent precipitation causes a reduction in particulate matter as does greater mixing depth.[14] The relationship between particulate matter and temperature is not very strong, but some scientific literature suggests that increased temperature may cause sulphate aerosols and volatile organic compounds to transition from the gas to the particle phase, contributing to an increase in secondary particulate matter.[15] [16] At the same time, increased temperatures may lead to decreased nitrate aerosols in areas with high levels of oxides of nitrogen.[17]

Bushfires and dust storms

In areas that are projected to become hotter and drier as a result of climate change, dust storms and bushfires will potentially increase, causing particulate matter to increase.

Bushfire smoke contains particulate matter, respiratory irritants and carcinogens such as benzene and formaldehyde. These can travel for thousands of kilometres. Hazard reduction burns, which are being conducted more frequently due to climate change, also contribute to increased pollution. Modelling suggests that fine particulate matter will increase across Australia over the lifetime of people alive today as a result of climate change, mainly due to an increase in fine dust particles and sulphate aerosols. This would lead to a five per cent increase in premature deaths, representing a loss of 6,000 years of life annually.[18]

Aeroallergens

Climate change will increase the impact of aeroallergens such as pollens and moulds, increasing rates of asthma and hay fever. For instance, higher carbon dioxide levels may affect flowering plant processes causing increased pollen production, increasing allergenicity of some pollens, extending the pollen season and changing the growing range of some allergenic plants. It may also cause the number of asthma thunderstorms, such as that which occurred in Melbourne in 2016, to increase. This particular storm was the cause of a catastrophic asthma epidemic.

13 West, J. J., Szopa, S., & Hauglustaine, D. A. (2007). Human mortality effects of future concentrations of tropospheric ozone. *Geoscience*, 339: 775–783.
14 Kinney, P. L. (2008). Climate Change, Air Quality, and Human Health. *American Journal of Preventive Medicine*, 35(5): 459–467.
15 Heald, C. L., Henze, D. K., Horowitz, L. W., Feddema, J., Lamarque, J. F., Guenther, A., … Fung, I. (2008). Predicted change in global secondary organic aerosol concentrations in response to future climate, emissions, and land use change. *Journal of Geophysical Research - Atmospheres*, 113(5): 1–16.
16 Liao, H., Chen, W., & Seinfeld, J. H. (2006). Role of climate change in global predictions of future tropospheric ozone and aerosols. *Journal Of Geophysical Research - Atmospheres*, 111(March): 1–18.
17 Pye, H. O. T., Liao, H., Wu, S., Mickley, L. J., Jacob, D. J., & Henze, D. K. (2009). Effect of changes in climate and emissions on future sulfate-nitrate-ammonium aerosol levels in the United States. *Journal of Geophysical Research*, 114: 1–18.
18 Fang, Y., Mauzerall, D. L., Liu, J., Fiore, A. M., & Horowitz, L. W. (2013). Impacts of 21st century climate change on global air pollution-related premature mortality. *Climatic Change*, 121: 239–253 (supplementary material).

Hunter Valley coal-fired power station. Credit Donna Green

What other factors also threaten future air quality and impact health?

Other factors that could contribute to worsening health impacts from air pollution in Australia include population growth and ageing, urbanisation, and increased transport and energy demands.

Australia's average annual population growth rate is 1.3 per cent per year. At this rate, Australia's population will rise from 23.9 million people in 2017 to 39.7 million by 2055. At the same time, life expectancy is increasing. By 2055, the proportion of the population that is over 65 is projected to more than double.[19]

Urbanisation is also projected to increase, with 74 per cent of Australians projected to live in one of Australia's capital cities by 2061, up from 66 per cent in 2012.[20] In addition, energy and transport demands in Australia are projected to continue to rise over the next 30 years.[21]

As people are more exposed to air pollution in cities, and older people are more susceptible to air pollution, these factors threaten to exacerbate health impacts from air pollution. Australia already faces a major health problem from air pollution. Climate change will make it worse. Mortality and illness rates from air pollution should dictate that we act immediately. And while the health impacts of air pollution and the impacts of climate change are linked, so are the solutions.

URBANISATION IS ALSO PROJECTED TO INCREASE, WITH 74 PER CENT OF AUSTRALIANS PROJECTED TO LIVE IN ONE OF AUSTRALIA'S CAPITAL CITIES BY 2061, UP FROM 66 PER CENT IN 2012.

What are the main sources of air pollution?

Urban and regional air pollution comes from a range of point sources and diffuse sources. Diffuse sources include motor vehicle emissions, domestic wood heaters, hazard reduction burns, agricultural burns and bushfires. Point sources include some commercial activities and industrial facilities such as coal-fired power stations and metal ore and coalmines.

The contribution of different sources varies between urban and regional areas. In order to find out the best way to improve air quality, it is necessary to understand the respective contributions of these sources. The main sources of air pollution nationally are described below. The contribution of these sources varies between rural and urban areas and also between seasons. In some areas, domestic wood heaters and agricultural sources are large contributors to local air pollution, despite not featuring in the national figures for the main sources of air pollution.

19 The Commonwealth of Australia. (2015). Intergenerational Report Australia in 2055.

20 Australian Bureau of Statistics. (2013). Population Projections, Australia, 2012 (base) to 2101. Available: http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/3222.0main+features32012 (base) to 2101 [Accessed 21 Sept 2017].

21 Bureau of Resources and Energy Economics (BREE). (2011). Australian energy projections to 2034–35, BREE report prepared for the Department of Resources, Energy and Tourism, Canberra.

Blasting at open cut coal mines, such as this one in the Hunter Valley, NSW, release large amounts of coarse particulate matter. Credit Donna Green

Electricity generation from coal-fired power stations

The National Pollutant Inventory reports that electricity generation is the largest source of fine particulate matter, oxides of nitrogen and sulphur dioxide. The power industry is also the largest source of atmospheric mercury. Coal-fired power stations also emit a range of other pollutants including carbon monoxide, coarse particulate matter and volatile organic compounds.[22]

Australia currently has 17 operating commercial coal-fired power stations in Queensland, Victoria, New South Wales and Western Australia. While these power stations are in non-urban areas, they are major contributors to local air pollution. Their pollutants, such as fine particulate matter, can travel vast distances and so can make up a significant proportion of fine particulate pollution concentrations in Australia's major cities. A major source of nitrogen dioxide and sulphur dioxide in Sydney's air, for example, comes from electricity generation from coal-fired power stations located in the Central Coast and Hunter Valley.[23]

Motor vehicle emissions

After coal-fired power stations, motor vehicle emissions are the second largest source of oxides of nitrogen and carbon monoxide nationally. They are also the second largest source of total volatile organic compounds, and the third largest source of lead and its compounds. Further, motor vehicle emissions contain a range of other air pollutants, among them fine and coarse particulate matter and air toxics such as benzene. In the Sydney region, motor vehicle emissions are the main source of coarse particulate matter from diffuse sources.

Metal ore and coal mining

Metal ore mining and coal mining are respectively the largest and second largest source of coarse particulate pollution nationally. In addition, metal ore mining is the second largest source of airborne lead nationally and the fourth largest source of oxides of nitrogen. Metal ore mining and coal mining are also the second and third largest sources of fine particulate matter respectively.

Hazard reduction burns and bushfires

Hazard reduction burns and bushfires contribute significantly to air pollution in Australia. Hazard reduction burns, agricultural burn-offs and bushfires are recorded in the National Pollutant Inventory as the main source of carbon monoxide nationally, and the third largest source of oxides of nitrogen. When they occur, hazard reduction burns and bushfires can cause extreme peaks in air pollution levels.

22 Department of Environment and Energy, Australian Government. (2017) National Pollutant Inventory. Available: http://www.npi.gov.au/home [Accessed 21 Sept 2017].
23 EPA. (2012). 2008 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW, Technical Report No.1 (pp.171; 156).

Bushfire smoke over the Northern Territory. Credit: Donna Green

How is air pollution regulated in Australia?

State and Territory governments regulate air pollution in Australia. National reporting standards and goals have been set for six common air pollutants known to damage health.

These standards are called the Ambient Air Quality National Environment Protection Measures (AAQ NEPMs). State and Territory governments are required to monitor these six air pollutants, and report on them annually. State and Territory governments regulate air pollution through policies, legislation and strategies, with varying degrees of enforceability.

In each state some form of pollution fee scheme is in operation. It requires polluting industries to pay a fee for a licence to emit pollution. The scope of these pollution fee schemes varies across jurisdictions. In some states the fee is just enough to recover the cost of administering the licensing regime, whereas in states such as New South Wales, South Australia, Western Australia and Victoria a component of the fee, based on the pollution load emitted, has the objective of incentivising abatement. There are, however, a number of problems with this system of regulating air pollution, both at the national and state level.

STATE AND TERRITORY GOVERNMENTS REGULATE AIR POLLUTION IN AUSTRALIA. NATIONAL REPORTING STANDARDS AND GOALS HAVE BEEN SET FOR SIX COMMON AIR POLLUTANTS KNOWN TO DAMAGE HEALTH.

THE GOALS:

Scientific literature on the impact of greenhouse gas mitigation suggests that a range of broader health and economic benefits arise from mitigation. In fact, global studies indicate that the potential health savings made by cutting greenhouse emissions are more than the costs of abatement in most countries.[24]

A study modelling the health co-benefits of greenhouse gas mitigation in Mexico City, São Paulo, Santiago and New York found that 64,000 deaths, 65,000 cases of chronic bronchitis and 37 million restricted-activity days could be avoided per year by making a 10 per cent cut in greenhouse gas emissions by 2020.[25] In Australia, no national quantitative study on the health co-benefits of mitigation has been yet undertaken.

Given the health benefits of greenhouse gas mitigation from overseas studies, the necessity for such research in Australia is long overdue. Some limited information is, however, available. Considering that air pollution is responsible for more than 3,000 premature deaths in Australia per year,[26] the costs of air pollution-related mortality alone have been calculated to be up to $24 billion per year.[27] A net zero emissions economy would clearly deliver substantial health benefits and, therefore, savings to the health budget that could help fund a clean energy transition.

To reduce the impact of climate change on air pollution and health, this Blueprint recommends the following four goals and their associated actions. These goals and actions should be viewed and, where possible, enacted as a system of closely connected strategies – a 'policy mix'.

GOAL 1:

Reduce air pollution through strengthened regulations

The first problem with Australia's systems of regulating air pollution stems from the fact that the standards and goals outlined in the AAQ NEPM are not enforced. These standards are not compliance standards, rather, they are reporting standards and guidelines with no penalties applied if states do not meet them. Indeed, states do regularly exceed the standards. To illustrate, New South Wales has exceeded the annual average standard for fine particulate pollution (PM2.5) every year since monitoring was introduced.[28] Despite this, new polluting industries continue to be approved.

Action:

establish a *National Air Pollution Prevention Act*

To change the reporting standards into compliance standards, a mechanism of enforcement must be introduced. Establishing a *National Air Pollution Prevention Act* would encourage compliance, as it would enable the Federal Government to penalise states for failing to comply with the standards.

Action:

develop a national air pollution exposure reduction framework

The second problem with the current systems of regulating air pollution in Australia is that the AAQ NEPM standards and goals are treated as a safe limit of air pollution. The implication is that human health will not be affected if air pollution does not exceed the standards. This is not true. There is significant evidence to suggest that there is no safe threshold for particulate pollution.

There is, in fact, a relatively linear relationship between exposure to particulate matter and deleterious higher-level health effects, including premature death. Damage to health from exposure to particulate matter occurs at levels well below the national standards. There is a clear health benefit in reducing levels of particulate matter below the national standards. Unfortunately, there is nothing within the AAQ NEPM or state regulations to drive air pollution levels below the standards.

By contrast, in recognition of the fact that there is no safe threshold for some pollutants such as fine particulate matter, the European Union introduced an *Ambient Air Quality Directive 2008*. This is a mechanism designed to constantly push for emissions reductions towards the best achievable levels. This directive set a national exposure reduction target for PM2.5 for all member states. The specific exposure reduction target for each member state is calculated as a percentage reduction of PM2.5 by 2020, relative to a reference year of the 2010 Air Exposure Indicator.

An air pollution exposure reduction framework should be introduced in Australia to push for reductions in particulate matter and other 'non-threshold' air pollutants to reach targets below the standards outlined in the AAQ NEPM. The air pollution reduction framework would complement the existing AAQ NEPM standards.

24 West, J., Smith, S., Silva, R. Naik, V., Zhang, Y., Adelman, Z., Fry, M. M. Anenberg, S., Horowitz, L., Lamarque, J., (2013). Co-benefits of mitigating global greenhouse gas emissions for future air quality and human health. *Nature Climate Change*, 3: 885-89.

25 Cifuentes, L., Borja-Aburto, V., Gouveia, N., Thurston, G., & Davis, D. L. (2001). Assessing the Health Benefits of Urban Air Pollution Reductions Associated with Climate Change Mitigation (2000-2010): Santiago, São Paulo, Mexico City and New York City. *Environmental Health Perspectives*, 109 (3): 419–425.

26 Begg S, Vos T, Barker B, Stevenson C, Stanley L & Lopez A. (2007). The burden of disease and injury in Australia 2003. Cat. no. PHE 82. Canberra: Australia Institute of Health and Welfare. Available: http://www.aihw.gov.au/publication-detail/?id=6442467990 [Accessed 25 June 2017].

27 Access Economics. (2008). The Health of Nations: The Value of a Statistical Life. Report for the Office of the Australian Safety and Compensation Council. Available: https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwifwOrZ2IfXAhUJTrwKHQQIDy4QFgguMAE&url=https%3A%2F%2Fwww.safeworkaustralia.gov.au%2Fsystem%2Ffiles%2Fdocuments%2F1702%2Fthehealthofnations_value_statisticallife_2008_pdf.pdf&usg=AOvVaw0OMsl1rzJQuAV3sh1jfR4L [Accessed 21 Sept 2017].

28 Environmental Justice Australia. (2017). Toxic and Terminal: How Australian Power Station Regulation is Failing Communities. Available: https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwjNtZ75lLXWAhVJkZQKHdwEBN0QFggtMAE&url=https%3A%2F%2Fenvirojustice.org.au%2Fsites%2Fdefault%2Ffiles%2Ffiles%2FEJA_CoalHealth_final.pdf&usg=AFQjCNGQjrp6U0AyYatZTNoJt7jt1rvaFQ [Accessed 21 Sept 2017].

Action:

legislate binding national emissions limits

One method by which State governments regulate air pollution is to require polluting industries to pay a fee to obtain a licence or permit to pollute. These permits or licences set conditions such as pollution limits and how waste should be managed. There is, though, a lack of consistency in how emissions limits are set, both between states and for different industrial facilities.

For instance, because older power stations and brown coal-fired power stations are dirtier than newer and black coal-fired power stations, both the former have less stringent emissions limits. This lack of standardisation in emissions limits suggests they are more influenced by what is easily implementable at low cost than what is necessary to minimise health effects.

The emission limits across Australia for any type of coal-fired power stations are very poor by world standards. Despite the fact that nationally, coal-fired power stations are the main source of fine particulate matter, no coal-fired power station in Australia has an emission limit specifically for fine particulate matter. In addition, the emission limit for mercury in all states is significantly less stringent than the equivalent limit in China, the United States and Europe. In Victoria and Queensland, an emission limit for mercury does not even exist. In Victoria, the emission limit for coarse particulate matter is also less strict than in China, the United States and the European Union.[29]

Action:

install best practice pollution reduction technologies to coal-fired power stations

Setting standardised and binding emissions limits, based on international best practice, would encourage power stations to install best-practice pollution reduction technologies. This is an efficient and effective way to achieve reductions in air pollution emissions in the near term.

Action:

establish a national load-based licensing scheme with fees that fully account for the externalities of air pollution

Another problem is that pollution fees do not reflect the full externalities of pollution. The cost of obtaining a licence to emit pollution is not high enough to provide polluters with an incentive for abatement. The organisation Doctors for the Environment Australia have calculated that if load-based licensing fees in New South Wales were calculated to properly reflect the health externalities of air pollution, the fees would be 49 times the current levels.[30] This figure is an underestimate as it only accounts for the health costs associated with three air pollutants: sulphur dioxide, nitrogen dioxide and coarse particulate matter. It excludes pollutants known to be damaging to health such as fine particulate matter, mercury and other air toxics.

Furthermore, this fee does not account for the social and environmental damage caused by carbon dioxide. Carbon dioxide is not included in any of Australia's pollution fee schemes. The externality costs of coal-fired power generation in Australia have been estimated to be $42 per megawatt hour (MWh) for black coal and $52 per MWh for brown coal, based on figures adjusted from Europe and taking into consideration Australian population densities.[31]

If load-based licensing fees were set at a level that accounted for the full externalities of air pollution, our calculations indicate that the combined licensing fees for the five coal-fired power stations in New South Wales would be nearly $2 billion per year. In the absence of a carbon price, it makes sense to include carbon dioxide as a scheduled pollutant in load-based licensing schemes. However, this would not be necessary if a carbon price were to be introduced, as recommended in this Blueprint.

Action:

expand state government inspections of industries and increase penalties for industries that breach their licence conditions

When polluting industries do breach their pollution licences, they are rarely penalised. Within the last ten years, no coal-fired power station in Australia has been penalised for breaching their licence conditions.[32] Earlier this year, however, revelations that AGL has been knowingly manipulating pollution monitoring by burning cleaner 'blended' coal in their monitoring smokestack to manipulate pollution estimates, prompted the Environment Protection Authority to investigate all coal-fired power plants in New South Wales.[33] To overcome this problem, it is vital to expand government inspections of industries and to increase penalties for industries found to have breached licence conditions.

29 Environmental Justice Australia. (2017). Toxic and Terminal: How Australian Power Station Regulation is Failing Communities. Available: https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwjNtZ75lLXWAhVJkZQKHdwEBN0QFggtMAE&url=https%3A%2F%2Fenvirojustice.org.au%2Fsites%2Fdefault%2Ffiles%2Ffiles%2FEJA_CoalHealth_final.pdf&usg=AFQjCNGQjrp6U0AyYatZTNoJt7jt1rvaFQ [Accessed 21 Sept 2017].

30 Doctors for the Environment Australia. (2016). Submission to the NSW EPA on the load-based licensing scheme. Available: https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjcoMOspZ_XAhUEkZQKHVqICfcQFggoMAA&url=https%3A%2F%2Fwww.dea.org.au%2Fimages%2Fuploads%2Fsubmissions%2FNSW_-_Review_of_the_load-based_licensing_scheme_submission_12-16.pdf&usg=AOvVaw3vyh162bvzzVapJc8QJm3d [Accessed 2 Nov 2017].

31 Australian Academy of Technological Sciences and Engineering (ATSE). (2009). The Hidden Costs of Electricity: Externalities of Power Generation in Australia. Available: https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjD-32LTWAhULUbwKHd6QBysQFggoMAA&url=https%3A%2F%2Fwww.atse.org.au%2FDocuments%2FPublications%2FReports%2FEnergy%2FATSE%2520Hidden%2520Costs%2520Electricity%25202009.pdf&usg=AFQjCNHRuB5DFQwj6Pi9iNMPqOnt55z2xA

32 Environmental Justice Australia (EJA). (2017). Toxic and Terminal: How Australian Power Station Regulation is Failing Communities. Available: https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwjNtZ75lLXWAhVJkZQKHdwEBN0QFggtMAE&url=https%3A%2F%2Fenvirojustice.org.au%2Fsites%2Fdefault%2Ffiles%2Ffiles%2FEJA_CoalHealth_final.pdf&usg=AFQjCNGQjrp6U0AyYatZTNoJt7jt1rvaFQ [Accessed 21 Sept 2017].

33 Hannam, P. (2017). 'Mindblowing': NSW EPA probes coal-fired power plants over pollution claims. Sydney Morning Herald. 14th May. Available: http://www.smh.com.au/environment/mindblowing-nsw-epa-probes-coalfired-power-plants-over-pollution-claims-20170510-gw26lb.html [Accessed 21 Sept 2017].

GOAL 2:

Commit to 100 per cent renewable energy by 2050

Even with strengthened regulations, air pollution will likely worsen in the future without addressing the root of the problem – burning coal, oil and gas. In order to curb the health effects of burning these fuels, and to cut greenhouse gas pollution, the energy sector must transition to 100 per cent renewable energy. This will have a significant impact because the energy sector accounts for roughly three quarters of Australia's greenhouse gas emissions.

To meet its commitments under the Paris climate agreement, Australia must reduce its greenhouse gas emissions by 5 per cent below 2000 levels by 2020 and by 26-28 per cent by 2030. Unfortunately, despite continued government assurances that the nation will meet these targets, government modelling indicates that at current rates it will overshoot the 2030 target. Instead of achieving a goal of 26-28 per cent reductions below 2000 levels, Australia is more likely to achieve a reduction of just 5 per cent by 2030.[34]

The overall goal of the Paris Agreement is to limit the average temperature rise to below 2 degrees Celsius above preindustrial levels, and to pursue efforts to limit the average temperature rise to 1.5 degrees Celsius. To achieve this the world needs to reach net zero emissions by 2050.

Action:

set a binding national emissions reduction target to reach net zero carbon dioxide emissions by 2050, with interim targets focused on making deep cuts early

As a generational equity issue, the Federal government must adopt a binding emissions target of net zero carbon dioxide by 2050, allowing for ambitious interim targets that focus on making deep cuts early. To do so would require a 50 per cent reduction in carbon dioxide emissions each decade for the next two decades.

The longer any society delays action to cut emissions, the harder and more expensive it will be for future generations to do so. Even though statements of targets do not alone reduce greenhouse gas emissions, they do make the intent of the government clear and do help link short-term decisions to long-term goals. Such statements support business and household investment decisions.

Targets should be backed with a clear strategy with which to reach them: legislation, policy frameworks and programmes that support the transition, and certainty for business investments in renewable energy and energy efficiency. This strategy should be supported by a public awareness campaign, demonstrating to the community and businesses how targets will be reached. Everyone should be on board.

Modelling shows that it is both technically and economically feasible for Australia to achieve net zero emissions by 2050. To achieve this, it is necessary to switch the stationary energy sector to 100 per cent renewable energy by 2030. The stationary energy sector comprises electricity generation and domestic heating, as well as fuels used in manufacturing and some other commercial activities. The stationary energy sector produces the most health-damaging air pollution and is also the sector that contributes the most to greenhouse gas emissions, roughly 33 per cent.

Achieving reduced emissions in other areas of the energy sector, such as transport and industry, will require a switch away from fossil fuels in the stationary energy sector. Electric cars can only be zero-emission vehicles if the electricity used is from zero-emissions generation.

After meeting the goal of producing 100 per cent of stationary energy needs in 2030 with renewable energy, it will be necessary to produce more renewable energy to cater for increased demand from the industry and transport sectors as they switch to electrification.

34 Commonwealth of Australia. (2016). Australia's Emissions Projections 2016. Available: https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwikqrz1s7PWAhXLkZQKHdy8AHMQFgguMAE&url=https%3A%2F%2Fwww.environment.gov.au%2Fsystem%2Ffiles%2Fresources%2F9437fe27-64f4-4d16-b3f1-4e03c2f7b0d7%2Ffiles%2Faust-emissions-projections-2016.pdf&usg=AFQjCNHfzapc85ng7cYKv9j4HeUAbfBsVA [Accessed 21 Sept 2017].

Action:

extend the Renewable Energy Target to 2040

To facilitate a transition to 100 per cent renewable energy by 2050, the Federal Government must extend the Renewable Energy Target to 2040, with targets increasing each year. The existing Renewable Energy Target has facilitated a boom in renewable energy in Australia.

This year, 2017, set a record for investments in renewable energy, with $11 billion invested in projects already underway or set to start this calendar year. There are now over 5,600 MW of renewable energy projects in the pipeline, close to filling the 5,900 MW gap needed to meet the Federal Government's current target of acquiring 20 per cent of electricity from renewable energy by 2020. Rooftop solar photovoltaic (PV) is also projected to grow from less than 5,000 MW of installed capacity this year to over 20GW in the next two decades. This is an increase of more than 300 per cent on current installed solar PV capacity.[35]

Despite its success in stimulating investment in renewable energy, the lack of ambition of the Federal Renewable Energy Target has led the States and Territories to adopt much stronger and more ambitious targets.

To continue to drive long-term investment in renewable energy in the states and territories, it is imperative that the Federal Renewable Energy Target is extended in timeframe and scope. There is a strong risk that without extending the target, investment in large-scale renewable energy will decline after 2020.

The South Australian government set a target of meeting half of its electricity with renewable energy by 2020. South Australia has already achieved this goal and is aiming for 100 per cent as soon as possible.

Tasmania already provides 93 per cent of its power from renewable energy, but has set a target of 100 per cent renewable energy by 2022. The Australian Capital Territory has also set a goal of sourcing 100 per cent of its electricity from renewable energy by 2020. The Northern Territory and Queensland both have goals to source half of their electricity from renewable energy by 2030. New South Wales has outlined an 'aspirational objective' of reaching net zero emissions by 2050. Victoria has a renewable energy target of 25 per cent by 2020 and 40 per cent by 2025. The *Victorian Renewable Energy (Jobs and Investment) Bill 2017* commits Victoria to achieving its targets.

Action:

put a price on carbon dioxide emissions and set an increasing trajectory for this price

The second policy mechanism is to put a price on carbon, and this carbon price must increase over time. This will send a clear price signal to investors. This action would help compensate for the health and environmental costs of burning fossil fuels.

The need to transform the energy sector through these measures is supported by the fact that Australia's coal-fired power stations are coming to the end of their planned lifespans. Even without a carbon price, Australia's coal-fired power stations will likely be phased out by 2040.[36] [37]

Since 2012, roughly one fifth of Australia's coal capacity has been shut down without any policy directives. The average age of Australia's coal-fired power stations is 36 years, with some being much older. The normal lifespan of a coal-fired power plant is around 50 years.

Although in 2017 the Federal Government promoted new coal-fired generation, this is unlikely to be cost-competitive with renewables, nor attractive to private investment. It is unlikely to go ahead. Case in point: the newly approved Cooper's Gap wind farm in Queensland. It will deliver wind power at a cost of $60/MWh. This is competitive with a new-build high efficiency low emissions coal plant, which has been estimated (probably optimistically) by the Minerals Council of Australia to cost between $40-$78/MWh.[38]

A carbon price that increases over time would help facilitate the transition from coal to renewable energy. Funds raised through a carbon price could be used to establish and fund a national transition authority designed to minimise impacts of the transition on employees of coal mines and coal-fired power stations, as well as their surrounding communities. The authority would operate through regional redevelopment, retraining programs and other measures. Funds raised through a carbon price could also be used to help fund the transition away from fossil fuels to renewable energy.

35 AEMO (Australian Energy Market Operator). (2017). Electricity Forecasting Insights for the National Electricity Market. https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/EFI/2017-Electricity-Forecasting-Insights.pdf [Accessed 5 Oct 2017].

36 Climate Council. (2014). Australia's Electricity Sector: Aging, Inefficient and Unprepared. Available: http://www.climatecouncil.org.au/uploads/f9ba30356f697f238d0ae54e913b3faf.pdf [Accessed 21 Sept 2017].

37 Morton, A. (2017). Coal in decline: An energy industry on life support. The Guardian. 24th August. Available: https://www.theguardian.com/environment/2017/aug/24/coal-in-decline-an-energy-industry-on-life-support [Accessed 21 Sept 2017].

38 Potter, B. (2017). Don't buy The Minerals Council costings of coal power. Australian Financial Review. 6th July. Available: http://www.afr.com/business/energy/dont-buy-the-minerals-council-costings-of-coal-power-20170705-gx5enx [Accessed 21 Sept 2017].

Credit: Pexels

Action:

establish incentives to encourage consumers to support the broad-scale adoption of electric vehicles and invest in infrastructure for electric vehicles

Once Australia has moved its stationary energy sector to 100 per cent renewables, the nation will be well placed to focus on decarbonising other sectors of the economy, especially transport and industry.

The transport sector is Australia's third largest and fastest growing source of greenhouse gas emissions. Road transport makes up roughly 80 per cent of Australia's transport sector emissions. As well as encouraging people to drive less and use public transport more, as discussed below, an important step in decarbonising the transport sector is the electrification of transport, including private electric vehicles.

Although electric vehicles currently make up a small share of the global market, this is changing fast as more countries support the adoption of electric vehicles. The shift is causing the prices of electric vehicles to fall in many parts of the world.

The example of Norway demonstrates how simple government incentives such as removing import taxes, eliminating tolls and providing free parking and free recharge stations for electric vehicles can rapidly increase their adoption. Through these policy measures, Norway has put more electric vehicles on its roads on a per capita basis than any other nation.

Electric vehicles will fast transform the world's transport sector. Recent announcements such as that made by France and the United Kingdom to ban the sale of new petrol and diesel cars and vans by 2040, and China's decision to ban the sale of petrol and diesel vehicles by a deadline yet to be announced, has sent a strong signal to investors. As the world's largest car market, China's announcement will have a particularly significant influence on the global car industry. Volvo has also recently announced that from 2019 onwards it will only produce hybrid and electric vehicles. The Queensland Government this year announced that it would build one of the longest electric vehicle superhighways in the world, with 18 fast charging stations that will charge a car battery in 30 minutes.

Action:

build a high-speed rail link between east coast cities and major regional areas

Emissions from domestic aviation are the second largest source of greenhouse gas emissions in the transport sector. They contribute roughly 7 per cent of transport emissions. The flight route between Sydney and Melbourne is the fourth busiest domestic flight route by passenger volume in the world.[39]

Where cost-effective, travellers must shift from high polluting transport to clean transport. To reduce domestic aviation emissions, Australia should invest in high-speed rail along the east coast between Melbourne, Canberra, Sydney and Brisbane, as well as major regional cities in between.

Switching to net zero emissions will require capital investment out to 2050 of approximately $800 billion dollars compared to a reference scenario based on continuance of the status quo and Australian government forecasts, of $150 billion.[40]

However, because renewable technologies do not require ongoing fuel costs, it is estimated that 110 per cent of the capital investment required for them would be paid off through fuel cost savings by 2050. This would be made up of $340 billion of power sector fuel savings and $400 billion of transport sector fuel savings.[41]

39 International Air Transport Association (IATA). (2016). 60th edition of IATA world transport statistics. Available to be purchased from: http://www.iata.org/pressroom/pr/Pages/2016-07-05-01.aspx [Accessed 21 Sept 2017].
40 Teske, S., Dominish, E., et al. (2016). 100% Renewable Energy for Australia – Decarbonising Australia's Energy Sector within one Generation. Report prepared by ISF for GetUp! and Solar Citizens, March 2016.
41 Ibid (2016), p. 3.

GOAL 3:

Promote sustainable and liveable cities

Australian cities are low density by international standards, with a high reliance on cars. This means that many Australians spend a considerable amount of time commuting by car each day, impacting their work-life balance. The average Sydneysider spends 35 minutes getting to work, compared to 32 minutes in Melbourne and 29 minutes in Perth.[42]

Action:

develop regional and suburban mini-cities

These low-density suburbs and long commutes contribute to Australians being some of the highest per capita greenhouse gas emitters in the world. To reduce transport emissions and create more sustainable cities, it is necessary to reimagine how suburbs are planned and built. The '20-minute cities of the future' should be the model. In such cities residents can access relevant services like employment, education, shopping and entertainment within 20 minutes.

Action:

promote active modes of transport and deliver more public transport services with improved access

These 20-minute cities will be decentralised with polycentric suburban and regional hubs, or mini-cities, linked by an efficient public transport system with improved access and services. Mini-cities should be zoned to facilitate medium density, mixed-use developments that provide work, housing, retail, finance and cultural services in close proximity. Designing cities in this way facilitates getting around by foot or bicycle thereby encouraging these active modes of transport.

Action:

transform building stock to net zero emissions

Improving the energy efficiency of buildings is one of the the most cost-effective ways to reduce energy use and greenhouse gas emissions. Transforming building stock into net zero emission mode is a cost-effective way to cut greenhouse gas emissions. Net zero emission buildings produce as much energy from renewable sources as they consume. At present the average thermal efficiency of our homes trails a long way behind the average thermal efficiency of homes in many other countries. As a consequence, Australian householders use more energy – electricity and gas – for heating and cooling.

In 2003 the Building Code of Australia adopted minimum energy efficiency standards which were subsequently adopted by State and Territory governments and given legal effect by relevant legislation in each state and territory. These efficiency standards need to be strengthened. Moreover, the building codes in states and territories, only apply to new housing stock, which represents just 2 per cent of the housing market per annum.

To achieve net zero emissions housing stock, it is essential to strengthen the building codes and provide incentives for households to install solar PV panels, energy efficient appliances and to carry out dramatic energy efficiency retrofitting. These improvements would also significantly cut household power bills.

Action:

set ambitious targets for urban greening

The average annual temperature in cities of over one million people is between 1 and 3 degrees Celsius hotter than surrounding areas because of the urban heat island effect.[43] This effect is caused when green areas with trees and grass, that evaporate cooling moisture, are replaced with dense building materials such as concrete which absorb more heat. Even small increases in heat can cause disproportionately large effects on our health and on the economy.

It is vital that green areas in cities are substantially increased. Trees sequester carbon dioxide and trap urban air pollutants such as nitrogen dioxide, ozone, and fine particles. Trees also provide shade, helping to cool buildings and pavements. Greening plans and strategies already exist in most of our capital cities.

> Adelaide City Council has introduced a $1 million program to introduce trees into urban spaces, Brisbane City Council has a goal to plant 2 million trees and Melbourne has developed an Urban Forest Strategy, which aims to increase tree canopy cover from 22 to 40 per cent by 2040, increasing diversity of species and improving soil moisture. The City of Hobart has a plan to maintain 60 per cent of the city area as parklands or native bushland, and Perth is currently implementing its fourth urban forest plan.

As well as planting more trees, city councils should incorporate more parks and kerbside gardens throughout the city and encourage rooftop gardens and green roofs. The City of Sydney currently has tree canopy cover of 15 per cent. An increase in urban greenery of 10 per cent could effectively decrease the precinct temperature by 0.6 degrees Celsius.[44]

42 Bureau of Infrastructure, Transport and Regional Economics (BITRE). (2016). Five facts about commuting in Australia, BITRE, Canberra.
43 US EPA (United States Environmental Protection Agency). (2008). *Reducing Urban Heat Islands: Compendium of Strategies*. Available: http://www.epa.gov/hiri/resources/compendium.htm. [Accessed 21 Sept 2017].
44 Sharifi, E., Lehmann, S. (2015). Correlation analysis of surface temperature of rooftops, streetscapes and urban heat island effect: Case study of central Sydney. *Journal of Urban and Environmental Engineering*, 9 (1): 3-11.

GOAL 4:

Manage the health risks from poor air quality

While effective policies to reduce air pollution at source are preferable, a range of additional policies and actions would help reduce individual and community health risks from poor air quality.

Action:

assess the risk of asthma epidemics and improve early warning systems

The influence of aeroallergens on the incidence of asthma and hay fever will likely increase as a result of climate change. Aeroallergens can have a large impact on air quality and are difficult to reduce at source. Increased carbon dioxide in the atmosphere may cause allergenic plants to produce more pollen, and may increase the allergenicity of some pollens. Climate change may also increase the spatial distribution and range of some allergenic plants, as well as increasing the duration of the pollen season.

An extreme example of this effect is that of an asthma epidemic. This can occur when hot and humid conditions coincide with storms, causing grass pollen to rupture into tiny fragments, exposing large numbers of people to these tiny pollen fragments in a short time period. These tiny fragments of pollen can easily lodge in the respiratory tract.

This is what caused the asthma epidemic that occurred in Melbourne in November 2016. A subsequent inquiry concluded that, although it was impossible to know that the asthma epidemic would occur on such a catastrophic scale, the risk of its occurrence was predictable. Even so, emergency services were not adequately prepared.

The Victorian Government has subsequently devised a management plan. It includes funding for training, research, monitoring and interpretation of pollen data, and a new emergency warning system. The plan began on October 1, 2017. States and territories should assess the risk of similar asthma epidemics occurring and follow the relevant recommendations.

Action:

develop air quality forecasting tools to plan hazard reduction burns

More hazard reductions burns are needed to reduce the increased risk of bushfires due to climate change. Unfortunately, smoke from hazard reduction burns has the same or worse impacts on health as smoke from naturally occurring bushfires.

Smoke from hazard reduction burns has a tendency to accumulate close to the ground. This is due to the fact that hazard reduction burns are usually conducted on less windy days to minimise the risk of spread. Hazard reduction burns also burn at a lower temperature than bushfires. These factors can cause hazard reduction burns to produce more air pollution than bushfires.

In May 2016, hazard reduction burns that took place around Sydney caused air pollution in the Sydney basin to be worse than Beijing for a number of days.

A study of these hazard reduction burns found that they caused 14 premature deaths, 58 respiratory hospitalisations and 29 cardiovascular hospitalisations.[45]

In order to reduce the risk of exposing large populations to health-damaging smoke from hazard reduction burns, it is essential to develop air quality forecasting tools that enable burn times to be planned when meteorological conditions are conducive to dispersing air pollution. It is necessary to conduct health impact assessments of hazard reduction burns before they occur, and to more effectively communicate scheduled hazard reduction burns to the public.

Action:

increase monitoring of air pollutants

To make informed planning decisions, more rigorous data on all types of air pollution emissions and ambient air quality must be delivered more quickly. Such data are needed to effectively monitor and evaluate whether or not measures introduced to reduce air pollution and improve general air quality are working. This will assist reduction of exposure in populations living close to polluting industries.

However, gaps exist in air quality monitoring by state governments. The AAQ NEPM focuses on monitoring general air quality. They do not provide for monitoring locations close to polluting industries where people are breathing in high levels of air pollution every day including fine and ultrafine particles.

The AAQ NEPM say that monitoring sites must be located in places that give a representative sample of air quality, and are only needed in areas with 25,000 people or more. Consequently, at the present time, monitoring sites are generally installed away from air pollution sources and also away from small communities.

To rectify this problem, the focus should be on known pollution hotspots such as near coalmines, coal-fired power stations, other polluting industries and major roads. Additionally, smokestack monitors should be installed on coal-fired power stations to collect data on air pollutants such as particulates, nitrogen dioxide, sulphur dioxide and mercury. The data should be released in real time to the public. Doing so would enable people living in close vicinity to pollution sites to monitor their exposure to air pollutants.

45 Broome, R. A., Johnston, F. H., Horsley, J., & Morgan, G. G. (2016). A rapid assessment of the impact of hazard reduction burning around Sydney, May 2016. *Medical Journal of Australia*, 205(9): 407–408.

Sydney CBD, 6th May 2016.
Credit: Climate Change Research Centre, UNSW

Sydney CBD obscured by air pollution from hazard reduction burns, 7th May 2016.
Credit: Climate Change Research Centre, UNSW

Action:

establish a National Air Quality Data Service

As the results of air quality monitoring are collected, managed and reported in separate state or territory databases, a National Air Quality Data Service would improve access to nationwide information. This would allow better comparisons between states and territories – and better forecasting.

Action:

run a major public health campaign

Although reducing pollution at the source is vastly preferable, for some susceptible and vulnerable groups, there is merit in taking actions to reduce personal exposure to air pollution. A major public health campaign is warranted to raise public awareness about the damaging health effects of air pollution, and how everyone can play their part in reducing pollutants.

To illustrate this point, few Australians consider the health implications of the pollution from their car, or from using electricity from coal-fired power stations. Improved public awareness – and awareness by politicians – would deliver major benefits to the Australian population, given the known health implications of burning fossil fuels. For example, people could turn off their idling engines when stuck in traffic or at traffic lights. People can choose to buy energy-efficient appliances. People can also, to some degree, reduce their own exposure to air pollution and be better prepared to respond in the case of emergencies.

Implementing the actions outlined in this Blueprint would avoid billions in associated health costs from poor air quality and thousands of future premature deaths. It would also help us to create healthier, more liveable cities. Finally, it would enable us to contribute our fair share towards global greenhouse gas emissions reductions necessary to meet the goals of the Paris Agreement. Investments in energy infrastructure and urban planning made today will have a lifetime of many decades. It is crucial that these decisions are made with care and foresight, to build a healthy future for all Australians.

IT IS CRUCIAL THAT THESE DECISIONS ARE MADE WITH CARE AND FORESIGHT, TO BUILD A HEALTHY FUTURE FOR ALL AUSTRALIANS

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