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Future trends

Australia is influenced by domestic and global trends, now and into the future.

While change is constant, it is increasingly complex and interrelated. The pace of change today is rapid and accelerating. These forces play a role in creating an uncertain environment for policy and investment, which has implications for Australia's infrastructure over the coming 15 years.

We have identified seven significant and interconnected influences for the future:

- Quality of life and equity
- Cost of living and incomes
- Community preferences and expectations
- Economy and productivity
- Population and participation
- Technology and data
- Environment and resilience.





2.1 Introduction



The future is uncertain

Australia is facing a future of uncertainty that brings both challenges and opportunities. While we have experienced profound change before, the scale, pace and interconnected nature of change today – to technology, to the people who live here, to our economy and our environment – are unprecedented.

While the priorities of individuals may vary, we have identified seven significant and interconnected influences for the future:

- Quality of life and equity
- Cost of living and incomes
- Community preferences and expectations
- Economy and productivity
- Population and participation
- Technology and data
- Environment and resilience.



The Audit looks to the future to understand the expectations of infrastructure

Increasingly complex and interrelated global, national and local trends are changing the way we live, what we consume, how we work and our economic opportunities, as well as our health and social connections. In turn, these trends influence our future infrastructure needs and expectations, and the capacity of industry and governments to plan, build, manage and fund a response.

Historically, we have looked back to recent experience in order to plot a course for the future. Assuming a linear growth or that more of the same will suffice is increasingly unreliable in a world prone to digital disruption, unequal distribution of access to infrastructure and slower growth. Complex external influences, new trends and innovations have made the use of the past to predict the future more difficult and created greater variation in the results.

However, in this climate of uncertainty planning and preparing for the future is no less important, in fact it is critical.

Internationally, some governments are responding by moving beyond the traditional ‘predict and provide’ approach to a forward-looking ‘vision and validate’ model, using the principles of foresighting. The *Australian Infrastructure Audit* has adopted important elements of this approach to provide an impartial perspective on the most significant influences on the infrastructure sector over the next 15 years. This perspective is important to allow an effective response that looks beyond individual sectoral silos, to focus on user needs and outcomes.

Our approach is to cast a critical eye over modelling and scenarios used in the past, to move beyond the continuation of past trends. It is crucial that detailed sector and project plans are based on evolving models to give a clearer perspective on what the future could entail.



Understanding the impact of macro trends is critical for understanding future needs

Strategic Foresight is a new field of research that tackles the context of uncertainty by identifying a balanced view of the different futures that may occur, in order to enable robust investment and reform decisions. Horizon scanning, that is the identification of national and global forces likely to impact Australians in coming decades, is a crucial first step in foresighting and the starting point for Infrastructure Australia in undertaking this Audit.

This approach will form the foundation of Infrastructure Australia's strategic policy framework. The Audit examines the key influences on the future of the infrastructure sector and consumer needs, considering the challenges and opportunities they present. The *Australian Infrastructure Plan*, our subsequent release, will consider policy responses to these challenges and opportunities, while the *Infrastructure Priority List* will identify responses via infrastructure investment. Infrastructure Australia also tracks the progress towards our recommendations through the *Prioritising Reform* report.¹

We have identified seven key influences

While the priorities of individuals may vary, we have identified seven significant and interconnected influences for the future:

- Quality of life and equity: our quality of life is high, but not everyone benefits equally.
- Cost of living and incomes: the cost of living is rising for some people, while incomes have not grown substantially.
- Community preferences and expectations: communities are expecting more customised, real-time and interactive services and products from governments and businesses.

- Economy and productivity: economic growth is slowing, while our economy is transitioning towards a service and knowledge-based future, which is increasingly located in our cities.
- Population and participation: our population is growing and urbanising, and participation in the workforce is increasing for women and older people.
- Technology and data: technology is transforming the way we live, but not everyone benefits equally.
- Environment and resilience: our environment is increasingly vulnerable to the effects of climate change, and our response to reducing emissions is falling behind international progress.

The interaction between these connected elements creates a unique period of uncertainty for the nation, and particularly the infrastructure sector. The scale, pace and interconnected nature of change make it challenging to predict how the future will look and what the precise impacts for Australia will be.

While many Australians enjoy a high quality of life, access to infrastructure and related opportunities is not equal. As Australia grows and changes, it will be important to balance future advances in quality of life and wellbeing with continued productivity growth through improvements in efficiency and competition. These influences should also form the basis for future infrastructure decision making.

In preparing for the future, we can also look beyond the immediate past to learn from the unique experience of others. This begins with our significant Aboriginal and Torres Strait Islander history of land management and settlement, art, culture and society that began over 65,000 years ago. It can teach us much about sustainability and resilience into the future. We can also learn from Australia's transformation as a nation over the last 200 years into the prosperous and diverse society we are today.

In this chapter

This chapter does not specifically discuss infrastructure. Rather, we present the broader context of change and identify future trends that will affect how Australia grows over the next 15 years and beyond.

The chapter does not predict or forecast, but explores the ‘big picture’ shifts occurring at the societal and systematic levels, and their potential impacts for Australia’s future. We have identified seven themes through which to view the challenges and opportunities our economic and social infrastructure sectors are set to face, as presented in subsequent chapters.

2.2 Quality of life and equity considers Australia’s overall quality of life and areas where living standards remain unequal because of social or geographic factors. It explores how unequal access is addressed through wellbeing and liveability frameworks to guide decision making and investment.

2.3 Cost of living and incomes considers the relationship between quality of life and the cost of living, and the impacts for people on lower incomes and those who live outside of the inner areas of fast-growing cities. It looks at changes to the cost of essential household items and services, against flat wages growth and high levels of household debt, reducing household budget resilience and capacity to pay.

2.4 Community preferences and expectations examines the changing preferences and expectations Australians place on institutions, services and products, largely enabled by technological advancements. Not all Australians are experiencing the benefits of Australia’s economic growth, and trust in governments and businesses appears to be falling. Governments and businesses are using improved technological capabilities to adapt to and shape changing community demands.

2.5 Economy and productivity reflects on Australia’s long-term positive economic growth and the ongoing shift to service and knowledge industries – the latter posing economic productivity benefits, but also contributing to uncertainty. At the same time, economic activity and jobs are increasingly located in urban areas. It also considers challenged public sector budgets, very low levels of net debt and opportunities for sustainable borrowing.

2.6 Population and participation shows that Australia’s population is growing, ageing and urbanising, providing opportunities but also posing challenges to our economic and social wellbeing. Participation in the workforce is increasing across Australia, particularly for women and older people who are working longer.

2.7 Technology and data considers the impacts of technology evolving at a faster rate, and in more interconnected ways, than ever before. This provides opportunities for improved decision making and individualised products and services. While Australia is an early adopter of consumer technologies, we struggle to commercialise our own innovations and expertise. Protecting data privacy and security is a challenge as our lives become more connected and digital.

2.8 Environment and resilience considers how Australian society has been shaped by, and relies on, its environment. Our environment is experiencing increasing weather extremes and threats to biodiversity from human activity, particularly due to the effects of global climate change. Australia’s response to climate change and environmental management is currently falling behind growing community support for change and international progress.

Quality of life and equity – snapshot

13.9 years

is the gap in life expectancy in remote and very remote areas between **Aboriginal and Torres Strait Islander peoples** and non-Indigenous people ²



In 2018,

Australia ranked 3rd

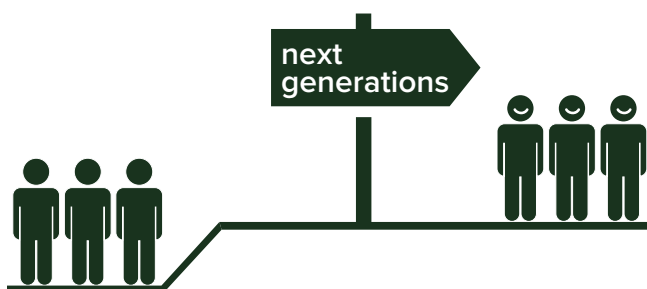
in the world on the UN's Human Development Index ³

Australia ranks 10th

in the OECD for life satisfaction ⁴



Only **1/3 Millennials** think they will be better off than previous generations ⁶



Australia ranks

31st in the OECD

for work-life balance ⁷

2.2 Quality of life and equity

At a glance

Australia’s quality of life is high, compared to other nations, thanks to our strong economy, natural resources, advanced knowledge sectors and healthy environment. However, not everyone has equal access.

This section looks at new wellbeing and liveability frameworks that can address equalities:

- for those on the outskirts of fast-growing cities, and in rural communities and remote areas
- for groups with existing disadvantage, such as lower-income households, children and older people, Aboriginal and Torres Strait Islander people, people with disability, and people from culturally and linguistically-diverse backgrounds.

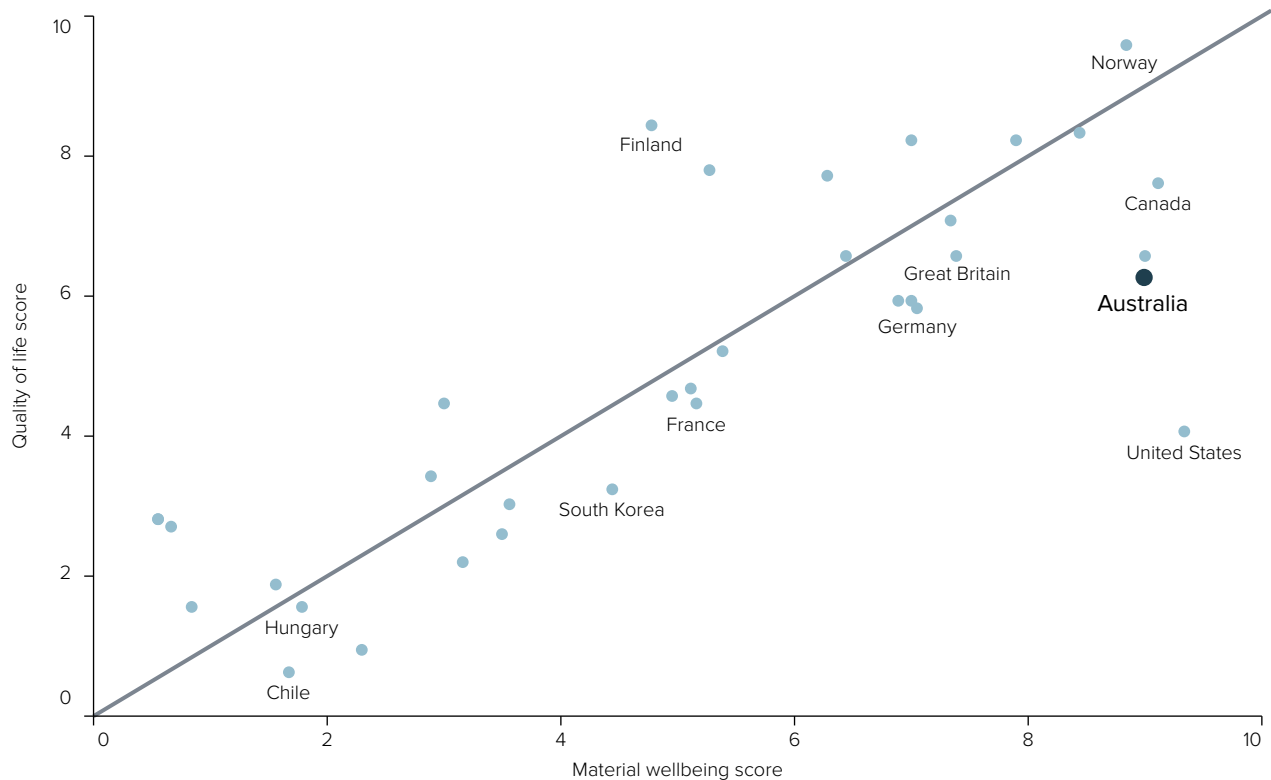
Australia has a high quality of life by international standards

Australians rightly expect a high quality of life – a high standard of health, wealth, happiness and choice in how they live. By international comparison, Australia’s quality of life is impressive, thanks to our strong economy underpinned by the natural resources and knowledge sectors, and our healthy environment and natural beauty.

In 2018, the United Nations ranked Australia third in the world on its Human Development Index, which measures countries according to whether people have long and healthy lives, are knowledgeable, and have a decent standard of living.⁸

Australia ranked positively in the 2017 Organisation for Economic Co-operation and Development’s (OECD) Better Life Index. The Index includes measures of material conditions (including levels of income and wealth, and access to jobs and housing) and quality of life (including work-life balance, health and education, social connections and civic engagement, governance, environmental quality, personal safety and subjective wellbeing) (Figure 1).⁹ Australia out-performs countries such as Japan, France and Germany on these metrics. This is largely thanks to our higher than OECD average life expectancy, higher education levels, higher household incomes, and the best air quality of any OECD country.¹⁰

Figure 1: Australia ranks well on the OECD comparative measure of quality of life and material conditions



Note: Material conditions encompasses ten indicators across three dimensions: income and wealth, jobs and earnings, and housing. Quality of life is measured through fifteen indicators spanning eight dimensions: work-life balance, health status, education and skills, social connections, civic engagement and governance, environmental quality, personal safety and subjective wellbeing.

Source: Organisation for Economic Co-operation and Development (2017)¹¹

Our largest cities also regularly rank highly in global liveability rankings, based on metrics including the quality of economic and social infrastructure, air and environmental quality, political stability, quality of housing, social connections, and cultural and entertainment measures. In 2018, Melbourne ranked second and Sydney fifth in the Economist Intelligence Unit's Global Liveability Index.¹²

Quality of life varies for different people and places

Despite our enviable global quality-of-life rankings, these benefits often fail to be distributed uniformly across the community. Over the past three decades, socio-economic inequality has risen slightly in Australia, but outcomes differ across population groups and places.¹³ On balance, we sit around the middle of OECD rankings for overall equality (measured by the Gini Coefficient).¹⁴

Income and wealth are key indicators of socio-economic equality. In 2018, the top 20% of Australian households by income earned five times as much as the lowest 20% of households.¹⁵ The perception associated with such a distribution will vary. It is inevitable that there will be higher rewards for skill and for risk. On the other hand, it is not inevitable that access to opportunity, health or education should also be skewed. Wealth is much more concentrated, with the wealthiest 20% of households owning nearly two-thirds of Australia's wealth.¹⁶ Yet Australian wealth distribution is rated as one of the more equal societies amongst developed world nations.

Experiences of inequality are particularly stark for groups of people facing 'deep and persistent disadvantage'.¹⁷ A growing proportion of Australians require welfare payments and services. Between 2006 and 2016, the number of welfare recipients grew by 3.4% annually, compared to a 1.6% growth rate for the total population over the same period.¹⁸ Certain groups are more likely to face disadvantage, including children, lone parents, those with disability, the unemployed, low-income or welfare recipients, and Aboriginal and Torres Strait Islander people. These people are most at risk of not having the financial capacity to access a full range of essential material items to maintain a good standard of living.¹⁹

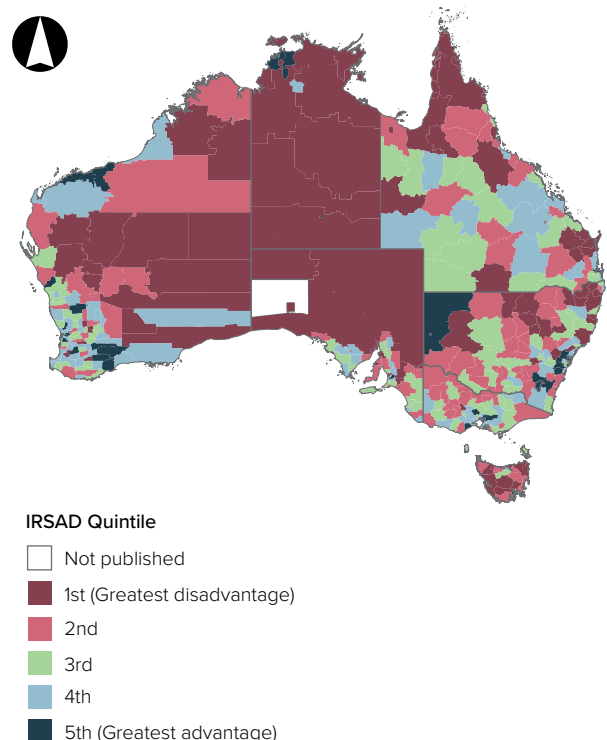
Other trends are placing greater pressure on vulnerable people, and creating issues of intergenerational disadvantage. These include an increasing proportion of older people and older women outliving men, increasing incidence of chronic disease, and housing affordability pressures.

Where people live can also affect their access to opportunities. Socio-economic advantage is concentrated in our fast-growing cities, with particular regions outside of cities benefitting from mining and agricultural activities. By contrast, a large number of remote areas across central Australia are the most disadvantaged in the country (Figure 2).²⁰

Very remote areas may only have the essential services, without access to higher-quality amenity and liveability, such as transport options beyond the car, or telecommunications networks to support advanced technologies. Lower health and educational outcomes are still prevalent in remote areas of Australia, compared to fast-growing and smaller cities and regional centres. Health and wellbeing outcomes are markedly lower for Aboriginal and Torres Strait Islander people in remote areas, where life expectancies are, on average, almost 14 years lower than that of other Australians.²¹

Life satisfaction also differs for different groups and places. For example, satisfaction is lower for people with mental health conditions, households with people who are unemployed, and people with disability.²² However, life satisfaction can also indicate quality of life beyond income and wealth. Despite fast-growing cities providing greater access to higher incomes, more services and providing better health outcomes, some people consider these places less attractive places to live than non-urban areas (with populations under 1,000 people).²³ Those living in non-urban areas report higher levels of life satisfaction.²⁴

Figure 2: Socio-economic disadvantage is most pronounced in rural and remote areas



Note: The Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) summarises information about the economic and social conditions of people and households within an area, including both relative advantage and disadvantage measures. Areas shown are local government areas.

Source: Australian Bureau of Statistics (2018)²⁵



Global jurisdictions are increasingly prioritising quality of life

Internationally, governments are increasingly recognising the importance of quality of life outcomes to people, communities and societies as a whole. In response, some governments are moving beyond traditional approaches to measuring the success of policies and investment, for example the use of economic tools such as Gross Domestic Product (GDP). These broader assessment frameworks appear to be useful inputs to national and regional planning processes. Research by the UK Office for National Statistics shows that strong correlations exist between reported positive wellbeing and happiness and other factors such as high self-reported health status, active employment, and higher income status.²⁶

At a global scale, the United Nations (UN) Sustainable Development Goals (SDG) framework presents an aspirational call to action across 17 goals with supporting indicators to measure progress. Australia, along with the other 193 member states of the UN, is a signatory. The Council of Australian Governments (COAG) adopted an indicator-based approach to assess progress towards its key commitments, inform project decision-making, monitor outcomes and review actions to align with outcomes.

While the goals primarily aim to assist developing countries to improve quality of life and wellbeing, as a developed country, Australia is not on track to achieve all of the 2030 targets. Australia's 2018 SDG global rank was 37 out of 156 and its total score of 72.9 (based on an assessment of capacity to reach the goals) was just below the OECD average of 76.9.²⁷

We perform well on measures of health, education, work and economic growth, and on sustainable cities. However, our overall progress towards the goals is slow. The goals of 'No poverty' and 'Good health and wellbeing' are the only SDGs that Australia is currently on track to achieve by 2030. Others such as 'Gender equality', 'Quality education' and 'Industry, innovation and infrastructure' are improving, but not at the required rate to meet the 2030 timeframe. Our progress towards 'Life on land' and 'Peace, justice and strong institutions' goals is not on track and has slowed.²⁸

Australia's slow progress towards the SDGs may be explained by a lack of integration of these types of measures into broader government decision-making processes. While embedding these considerations is a challenge, a number of OECD countries that have developed liveability and wellbeing frameworks to broaden the scope of their decision making have achieved SDG scores above the OECD average.²⁹

For example, in 2013, the UK Treasury developed a new appraisal method for government investment, the *Green Book for Central Government Guidance on Appraisal and Evaluation*, which includes consideration of quality of life and wellbeing, alongside a focus on environmental impacts.³⁰ In 2015, the French Government developed *New Wealth Indicators* to track progress against targets such as increased life expectancy, employment, and improved research and development outcomes.³¹

In Sweden, the *New Measures of Wellbeing* framework uses 15 economic, environmental and social indicators, alongside GDP, to measure economic sustainability and quality of life.³² The New Zealand Government's recent *Living Standards Framework* uses the OECD wellbeing 'domains' to ensure quality of life outcomes are considered at all levels of government decision making, particularly for investment in social infrastructure and services.³³

Cost of living and incomes – snapshot

The richest 20%

of households have five times
as much household income as

the lowest 20%

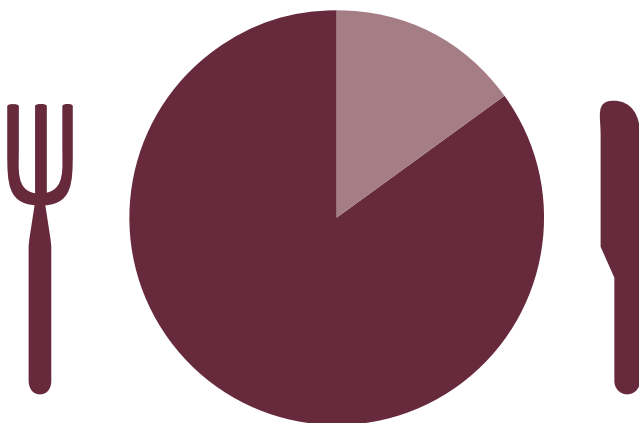
of households ³⁴



Borrowing for housing makes up around

**90% of total
household debt**

of Australians ³⁵



15%

of Australians
report experiencing
food insecurity ³⁶

Average wealth of a household in the highest 20% is
100 times that of a household in the lowest 20% ³⁷



In 2017, the poorest 50% of Australians had

3.7%

of national wealth, down from 3.9% in 2007 ³⁹



More than 1 million
households are in
mortgage stress
(Jan 2019) ³⁸

**1+
million**

2.3 Cost of living and incomes

At a glance

Our high quality of life translates to a high cost of living for many people. As income growth has slowed in the past decade, concerns about inequities (in access to services, and distribution of income) have risen – particularly outside fast-growing cities.

This section looks at the growing pressure on incomes, job security and household budgets as our economy changes.

Expectations of a high quality of life can push up the cost of living

Expectations of a high quality of life can correlate with higher costs of living. This is because a high quality of services and opportunities usually has a cost. Governments may invest substantial amounts of money to maintain a high quality of services and infrastructure, such as health care and education or even environmental responses (for example, climate change). Businesses must seek to recover the cost of higher-quality goods, services and housing. Costs may rise above households' ability to pay, which is determined by available incomes and wages.

Income and wage growth is slow, particularly outside fast-growing cities

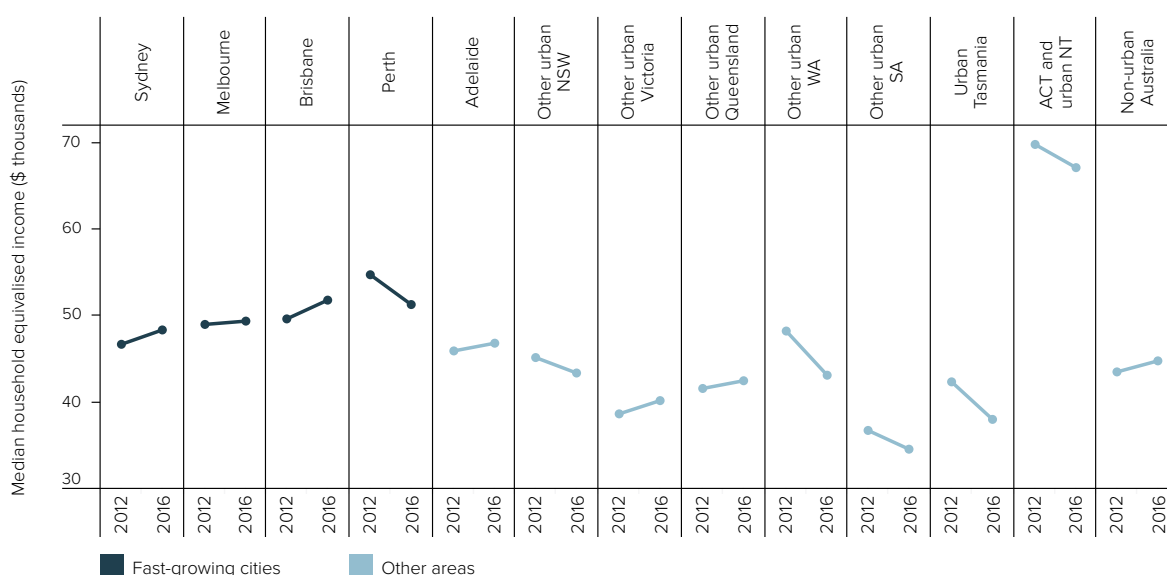
While Australian incomes have risen modestly over the past decade, overall growth has been limited. As Figure 3 shows, in recent years other than in fast-growing cities there have only been modest increases for some smaller cities and regional centres and in rural and remote areas. However, on balance, smaller cities and regional centres in Tasmania, South Australia, Western Australia and the Territories have experienced declines.

Income inequality has only increased marginally in Australia over the past 30 years, and contrary to popular perception has been flat in recent years. However, with much slower income growth – about half as much so far this decade compared with the previous – concerns about unequal access to services and income improvement opportunities have risen.⁴⁰ A 2018 survey conducted by the Centre for Economic Development Australia found that 31% of respondents indicated that they found living on their current incomes difficult or very difficult, and only 21% indicated they were living comfortably.⁴¹

We can partially explain trends of stalled income growth with reference to changes in workforce structure, and limited increases in real wage growth.⁴² Wage growth has slowed from 2.7% over the past decade to 2% over the past three years (Figure 4).⁴³

Job security is becoming a key issue, particularly as new sharing and 'gig' economies create a trend towards more transient and casualised workforces.⁴⁴ At the same time, growth in welfare and social security payments, which are generally linked to the consumer price index, has remained significantly below both public and private sector incomes over the past two decades, aside from a brief period during the global financial crisis (GFC) in 2007-08.⁴⁵

Figure 3: Median incomes have risen modestly in some fast-growing cities, but have declined in other areas



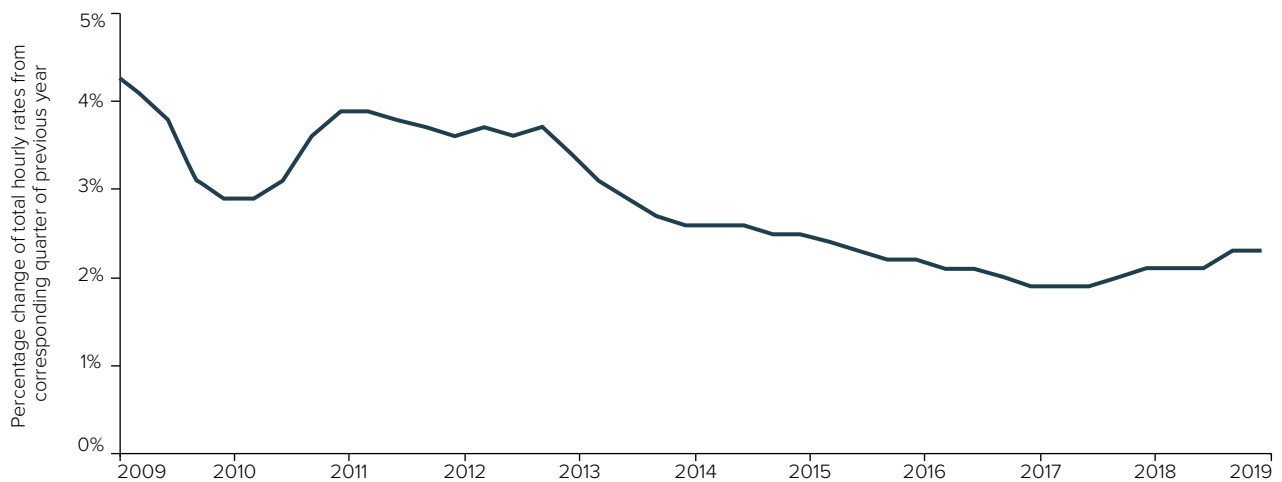
Note: This is drawn from the Melbourne Institute's Household, Income and Labour Dynamics in Australia Survey, which reports Australian Capital Territory and Northern Territory together. Values are inflation adjusted to December 2016.

Source: Wilkins and Lass (2018)⁴⁶

Wealth distribution is also a key indicator of the ability for households to pay for what they need and maintain a good quality of life. Within the OECD, Australia is the country with the seventh most distributed wealth, well ahead of comparable countries such as the United States and the Netherlands (Figure 5).

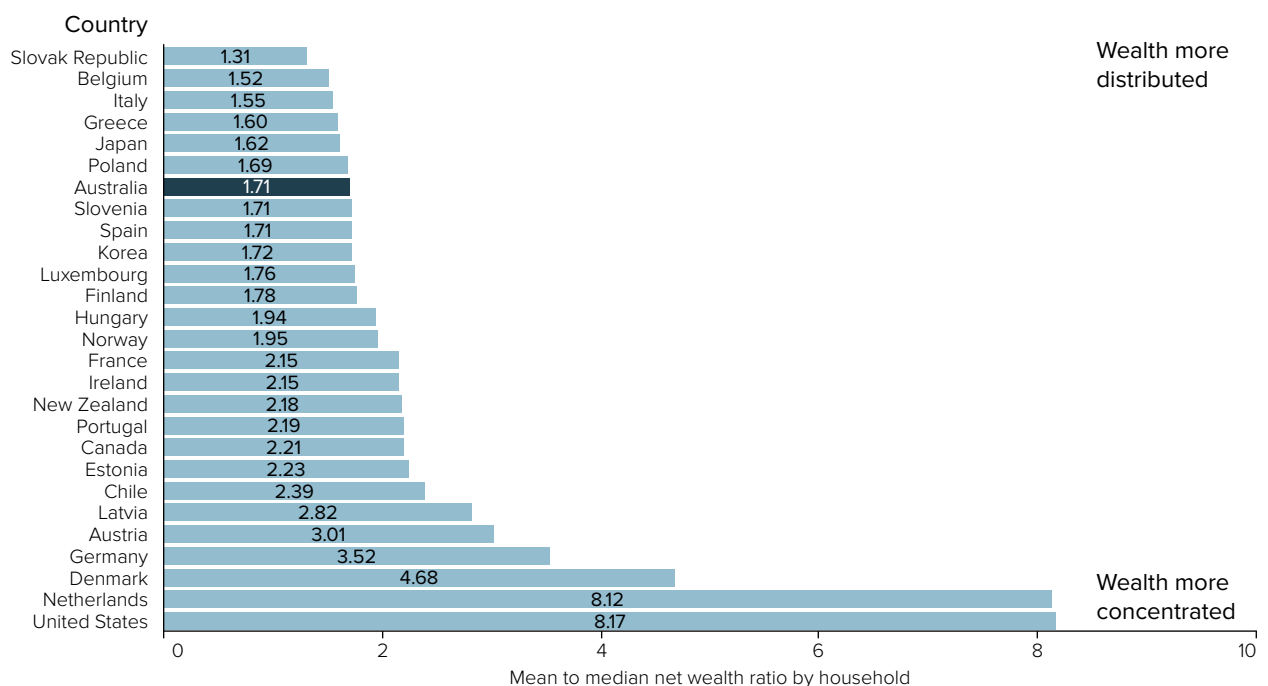
The distribution of wealth across Australian households is far from equal, but the biggest single equaliser is the relatively high level of home ownership in this country. The average wealth of a household in the highest 20% is 100 times that of the lowest 20%,⁴⁷ explained principally by the relative levels of home ownership and the tax advantages offered to it. There will undoubtedly be greater regional disparities in wealth distribution, due to increases in house prices, particularly in fast-growing cities of Sydney and Melbourne.

Figure 4: Real wage growth has stalled in Australia over the past decade



Source: Australian Bureau of Statistics (2019)⁴⁸

Figure 5: Australia's wealth is more evenly distributed than most OECD countries



Note: Values represent the mean wealth per household divided by the median wealth per household. Most recent ratios are shown for selected OECD countries. Year of data varies per country, from 2012 (Canada and Spain) to 2016 (United States). Australia's figure is from 2014.

Source: Organisation for Economic Co-operation and Development (2018)⁴⁹

The cost of essential services is increasing

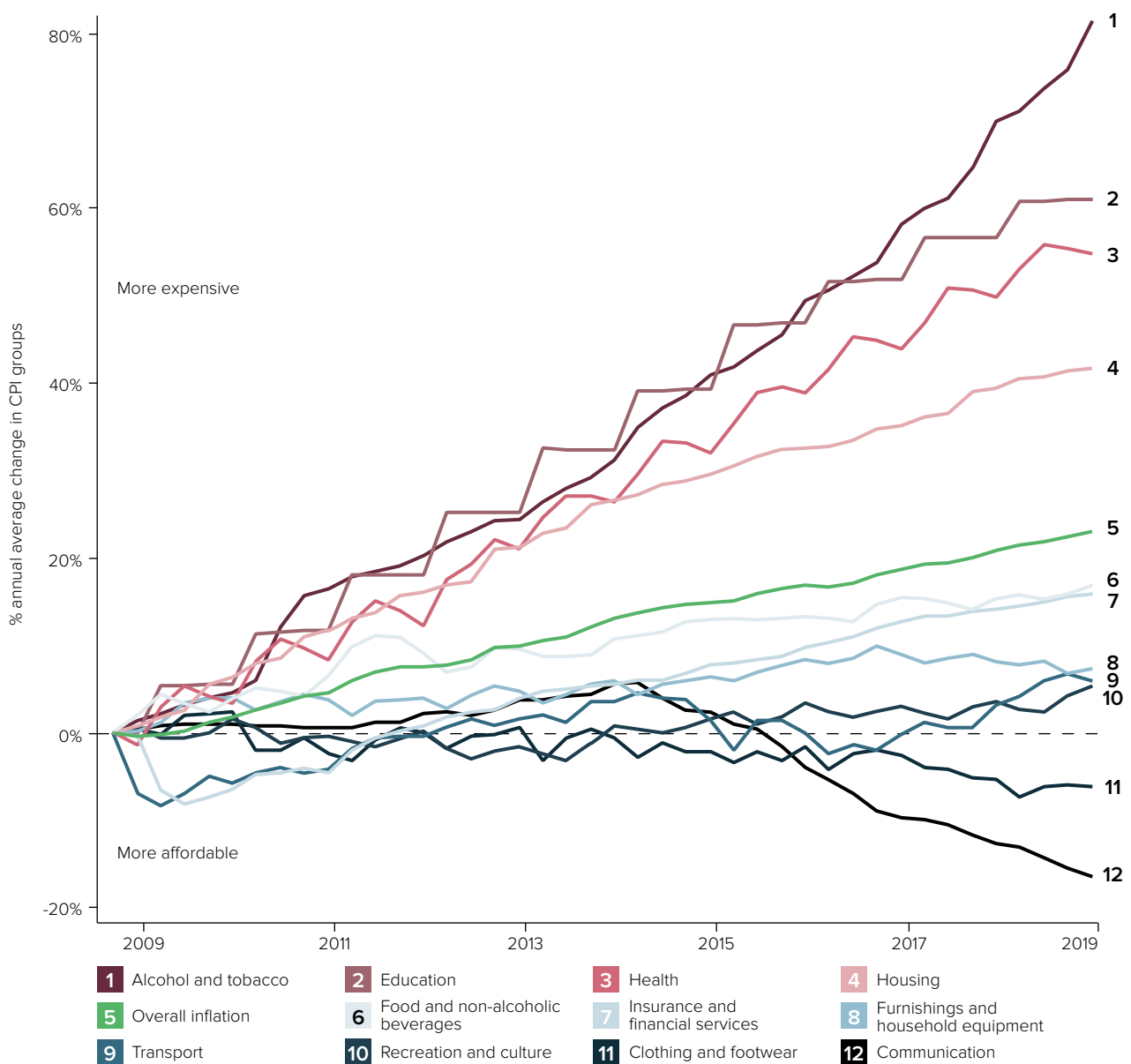
As Figure 6 shows, the total Consumer Price Index (CPI) (shown as overall inflation) has increased at around 2% over the past decade, but has slowed to around 1.5% over the past three years.

Figure 6 also shows that price changes vary for different groups of household expenditure items. Increases in the price of alcohol and tobacco have been underpinned by government taxation and regulatory measures to reduce consumption. While general food and non-alcoholic beverage prices have increased below overall inflation, in 2016-17,

15% of Australians indicated they had experienced food insecurity at least once.⁵⁰

Increases in the cost of housing (which includes house prices and rents, maintenance and repairs, and utilities) is the other side of the rapid rise in house prices, underpinned by a combination of demand, supply, financing and taxation arrangements. In contrast, the cost of communications, for example telephone and internet costs, has reduced over the past decade, and even more rapidly over the past three years.⁵¹

Figure 6: The cost of some essential goods and services such as housing have increased above inflation over the past decade



Source: Australian Bureau of Statistics (2019)⁵²

Some households are feeling these pressures more than others are. For employed households, the cost of living increased by 1.6% annually over the past three years, while age pension and self-funded retiree households have seen the cost of living increase by 1.8%.⁵³ Households receiving other government welfare payments have seen the cost of living increase by around 2%.⁵⁴

The cost of living also varies according to other demographic factors. Changes to household structures place different pressures on household budgets (for example, the additional cost of adult children staying in the family home while completing tertiary studies). The gender pay gap, childcare costs and workplace flexibility may also place pressures on households with young children and on single-parent households.

Geography also matters. Prices in cities, particularly for housing, are generally higher than prices in non-urban areas. However, wages are also generally higher in these areas, as high-value jobs tend to concentrate in inner urban centres. In the outer areas of our fast-growing cities, housing costs are often still high, and transport costs may be even greater than inner-urban areas. However, access to higher wages may be more difficult, placing pressure on household budgets. In rural and remote areas, lower housing costs, while attractive, can be coupled with lower wages and higher transport and other infrastructure costs.⁵⁵

Servicing the cost of housing is the largest pressure on household budgets

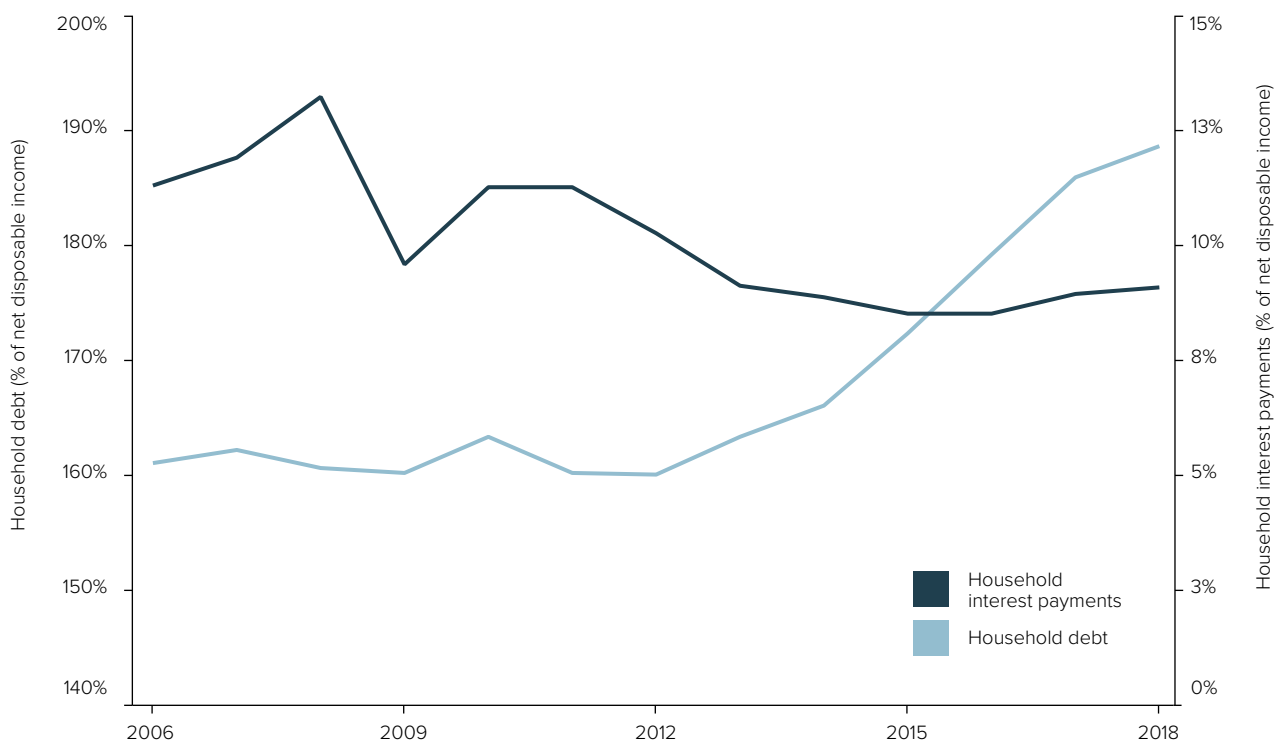
The largest pressure on household budgets comes from housing costs. Longer-term price increases have been driven by, among other things, low interest rates, strong investor interest in housing (partly due to volatility in other investment sectors such as the share market), and growth in population and household formation relative to growth in housing supply.

Many Australians are therefore spending large proportions of their household budgets repaying mortgages. For the average household in Australia, borrowing for housing makes up around 90% of total household debt.⁵⁶ In addition, the household debt-to-income ratio is rising, and at a faster rate than other countries.⁵⁷

In 2017, Australia's debt-to-income ratios was above the 75th percentile for OECD countries.⁵⁸ As Figure 7 shows, while Australia's household debt-to-income ratio is at an historical high, interest repayments to service that debt due to low interest rates has rarely been as low. Flattening house prices may ease these pressures, but an ongoing risk to household budgets will be potential future interest rate rises, particularly as real wage growth remains low.

The number of Australian households in housing stress rose between 0.4 percentage points (outer-urban Queensland) and 3.5 percentage points (Urban Tasmania) between 2001-04 and 2013-16 (Figure 8).⁵⁹ Housing stress is defined as those in the bottom 40% of household income distribution who spend more than 30% of that income on housing costs.⁶⁰

Figure 7: Household debt-to-income is historically high, supported by historically low interest rates



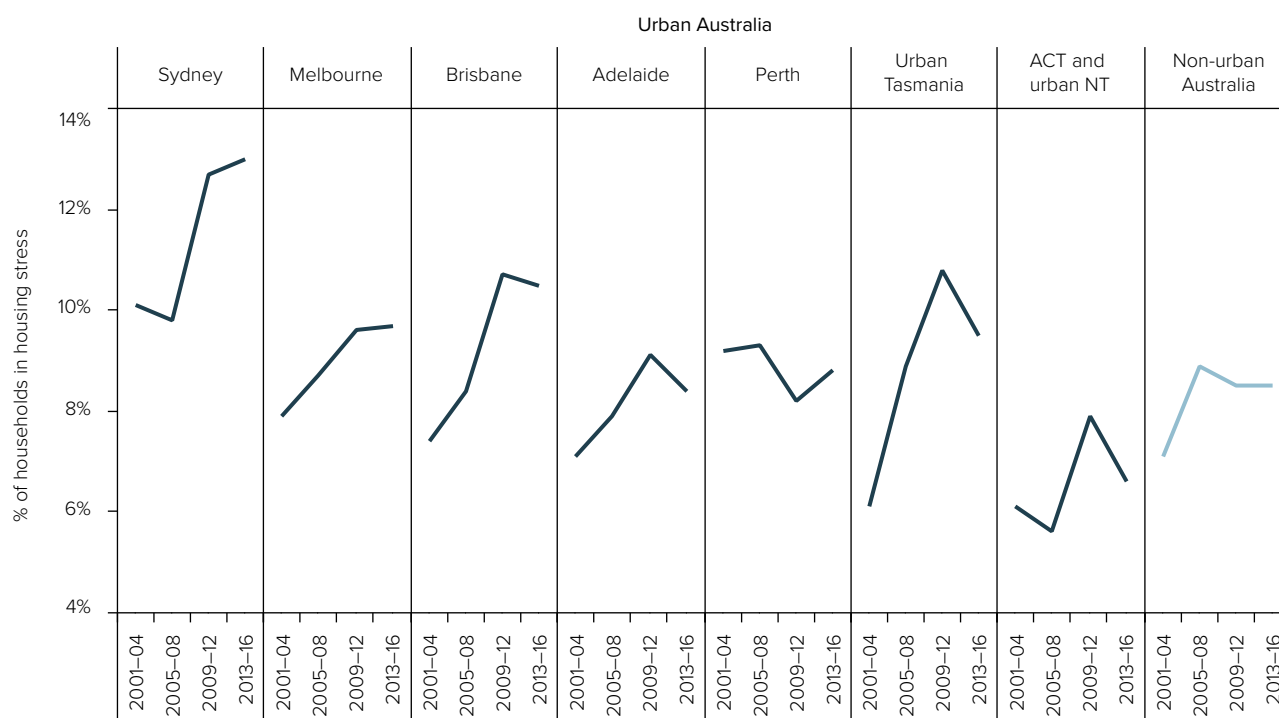
Source: Reserve Bank of Australia (2018)⁶¹



A combination of changing preferences and housing affordability pressures has driven a national shift away from home ownership to private renting over the last 20 years.⁶² Over the long term, household rental prices have increased in our fast-growing cities, with the exception of Perth where rental prices peaked in 2014 and have fallen substantially since then.⁶³ This presents a challenge as private renting in our fast-growing cities is now considered largely unaffordable for people on the median single income, pensioners and those on other benefits.

The availability of different types of housing, including affordable rental housing for key workers and those on lower incomes, is limited in Australia. Delivering housing that meets the needs of low-income people and employers in search of workers into the future will therefore remain a challenge in fast-growing cities.

Figure 8: Rates of housing stress have recently eased against a long-term negative trend



Note: This is drawn from the Melbourne Institute's Household, Income and Labour Dynamics in Australia Survey, which reports Australian Capital Territory and Northern Territory together.

Source: Wilkins and Lass (2018)⁶⁴

Community preferences and expectations – snapshot



42%

of Australians have
trust in government ⁶⁵



Airtasker
1.6m
users ⁶⁶



Uber
3.8m
users ⁶⁷

By 2028 women will control close to 75% of discretionary
spending worldwide ⁶⁸

75%

25%



**70% of
Australians**

have an on-demand video service subscription
(May 2018) ⁶⁹

75% of workforce

to be millennials by 2025 ⁷⁰

64%
of Australians

believe that climate change is
the most significant threat we face ⁷¹

2.4 Community preferences and expectations

At a glance

This section explores how community expectations are changing for governments, businesses, products and services. As society and technology advance, people want more choice and flexibility. However, expectations are not uniform across Australia. Different demographics have different needs and expectations.

While new markets and digital technologies are disrupting the economy, sustainability, ethical production and wellbeing are becoming higher priorities.

We must balance this need to meet liveability expectations while promoting economic growth and reducing our impact on the environment.

People are placing greater demands on businesses, products and services

We are living increasingly connected and digital lives. Our awareness of the world around us, and the impacts of our decisions and behaviours, is increasing. These preferences and expectations are often evolving ahead of government policy and regulation, and political cycles and processes, creating challenges in ensuring changes bring benefits to all communities.

People want greater choice and flexibility in their lives, in response to both social change and technological advancements. The expectations Australian communities place on governments, institutions, services and products are changing. Citizens, employees, customers and shareholders are expecting, and demanding, more. People are engaging more. For example, engagement with and amplification of news is increasing in Australia.⁷²

Technology has played a critical role in this change. Shopping, communication, banking, work and education are now at our fingertips. The internet has enabled the development of and access to more narrowly-focused products and services targeted at customised individual and community preferences, in a move away from more generic, mass-style production.⁷³ This includes entertainment, where people are increasingly choosing to pay for content variety and the ability to decide what they consume and when. For example, by March 2019, nearly 14 million Australians had access to some form of paid television or streaming subscription, an increase of 11.8% on the previous year.⁷⁴

Expectations of sustainability, ethical production and wellbeing are increasing

Both individual and collective actions towards reducing human impact on the environment are on the rise, particularly in fast-growing cities where availability of open space and access to nature can be restricted. This is particularly true of younger generations, as reflected in a 2019 UNICEF Australia

report that found Australian children are increasingly aware of the threat of climate change, and support embracing more renewable energy sources.⁷⁵

Balancing the sometimes competing demands for a high quality of life, economic growth and a healthy environment will be an increasing challenge for Australia into the future, particularly as our population grows and continues to urbanise, and as the impacts of climate change affect how our environment functions.

At the same time, some Australian communities, who have the capacity and flexibility, are joining a global trend towards promoting more ethical production and consumption of goods and services. This includes fair trade practices and non-animal testing, and extends to aspects of health and wellbeing, such as organic and chemical-free production. These trends have implications for the types and quality of agricultural products produced in our rural and remote areas, and for consumption across the nation.

Trust in institutions is declining

While opportunities for engagement are increasing, Australians' trust in institutions has fallen over the past decade.⁷⁶ Only 42% of Australians have trust in government.⁷⁷ This is driving demand for greater transparency and honesty in government decision making and a desire to be more involved in decision making about the future. In addition, people feel that the benefits of Australia's almost three decades of uninterrupted economic growth have not been shared equally, and large corporations, senior executives and foreign shareholders have benefited the most.⁷⁸

This is a global phenomenon. However, Australia sits towards the bottom of developed countries on rankings of trust, particularly for government and the media.⁷⁹ Women have notably lower trust than men do, particularly in non-government organisations, but also government and the media.⁸⁰ Declining trust (and an associated rise in cynicism) has a profound impact on the ability of governments to prosecute the case for important, but often difficult, reform and change in society.

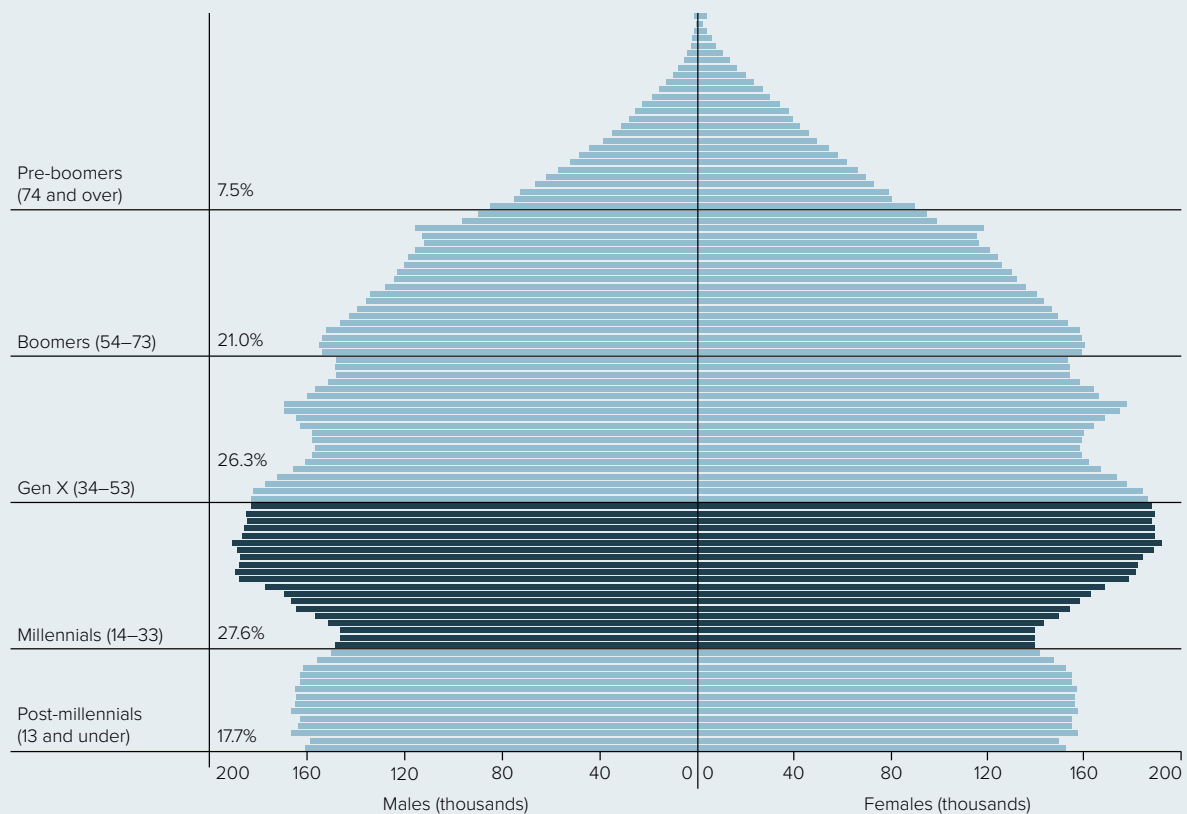
The impact of the millennial generation

The millennial generation (those born between 1986 and 2006) is Australia's largest cohort by population size (Figure 9). Globally, millennials will make up 75% of the workforce by 2025.⁸¹

This generation will increasingly influence Australia's economic, social and political future. Millennials are on average already highly educated, highly engaged with the digital and sharing economies, and are more ethically and environmentally engaged than previous generations.⁸² However, millennials and following generations are faced with greater uncertainty about the future of the environment, economy and liveability.⁸³

Younger generations are also demanding different lifestyles, influencing the delivery of products, services and housing choices. They are more likely to be older than previous generations when they marry and have children, and are experiencing declining rates of home ownership.⁸⁴ When they do settle down, they are more likely to live in smaller homes, particularly in areas with good-quality access to jobs, and show preferences for spending money and time on experiences over material goods.

Figure 9: Australia's largest generation by population size is the millennials



Source: Australian Bureau of Statistics (2018)⁸⁵

Preferences and expectations are not uniform across Australia

Community preferences differ across Australia. Overall, communities care most about access to affordable, quality health care and essential services.⁸⁶ However, people outside our capital cities place greater emphasis on employment opportunities and regional development.⁸⁷

At the same time, different communities have different priorities that translate into mixed demands, expectations and preferences. For example, younger people are focused on career opportunities and access to affordable housing, middle-aged people are focused on work-life balance and pay rises, while older age groups focus on health services, cost of essential services and regional development.⁸⁸ The purchasing power of women is projected to increase over coming decades, as workforce participation and earnings grow. By 2028, women will control close to three-quarters of discretionary spending worldwide.⁸⁹ As Figure 9 shows, all members of the boomer generation, who make up one-fifth of the population, will be aged 65 or over within the next 11 years. These people will place increasing demands on Australia's health and aged-care systems over this time.

It is also evident that not everyone is empowered by changing trends. Communities with less access to new technologies, either due to physical or financial constraints, struggle to engage with new ways of delivering products and services. For example, older generations or culturally and linguistically people may find it more difficult to engage with new technologies and risk missing out on the benefits these developments offer.

Increasing connectivity and use of technology are also changing consumer demands for and loyalty to some brands, products and businesses. Younger generations in particular are becoming more discerning when choosing brands and products.⁹⁰ With a growing diversity of brands on the market, consumers now search for authenticity and transparency, creating attachment beyond products and services. However, in a world of instantaneous communication and media channels, reputations can also be broken quickly and permanently.

These changing expectations and preferences create different demands on the way business, governments and the community function. For example, increasing demand for sustainable practices are driving shifts towards more ethical production, including resource use and labour. Demand for information transparency has encouraged businesses and governments to give people greater choice over how their information and data is gathered, stored and used. Businesses, including those in the retail and banking sectors, are increasingly capturing and using data to create more tailored experiences for customers. At the same time, open-source data is allowing the community

to create new solutions to address user preferences and improve quality of life for all, such as mapping the most convenient route through a city by wheelchair or with a pram.

Sharing markets are disrupting existing economies

Emerging sharing markets harness digital technology and connectivity to create new ways to use private goods and services and provide more cost-effective offers to consumers. This includes carsharing and ridesharing, co-working spaces, skill sharing, and peer-to-peer lending. Australians are increasingly embracing these new markets, often ahead of government regulation. For example, over 30% of Australians currently use ridesharing services, and a further 16% are likely to use them in the next 5 years.⁹¹ Ridesharing company Uber launched in Australia in 2012 and was formally recognised (after a period of legal ambiguity) as a legitimate service across all jurisdictions by 2017.⁹² Today, it operates in 39 Australian cities, with 3.8 million regular riders.⁹³

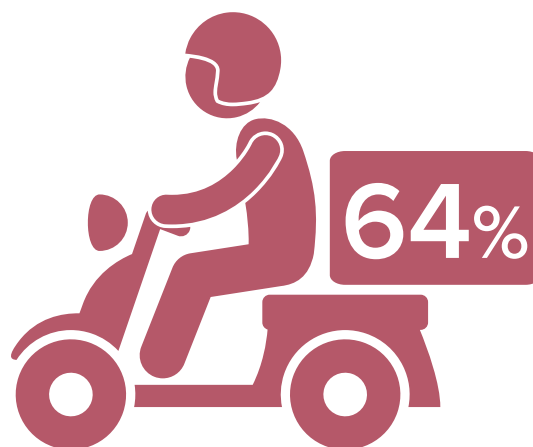
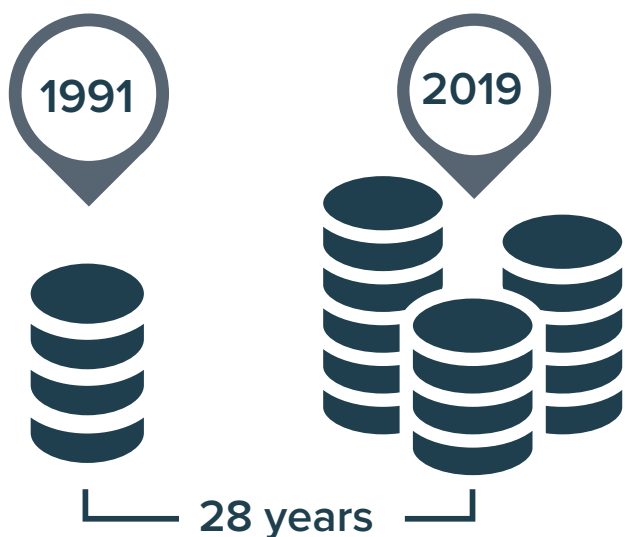
These emerging markets accompany changing consumer expectations of ownership and relationships to products. New markets may benefit consumers in the form of lower-priced or better-quality goods and services. Businesses may also benefit, in the form of lower labour and material costs. While there are potential benefits for workers too, particularly greater work flexibility and choice, there is uncertainty as to how employment models in new disrupting industries will affect the financial security of those working long term in a more casualised workforce.

Growth in the sharing economy and advancements in technology are also enabling the rise of 'prosumption' – the increased integration between production and consumption – in Australia. This could be as simple as a backyard vegetable garden where a family both produces and consumes the products, or a household with rooftop solar technology that produces and consumes energy, rather than paying to consume it from the grid. In turn, households can also make money by selling surplus supply – vegetables to local neighbours or stores, or energy back to the grid.

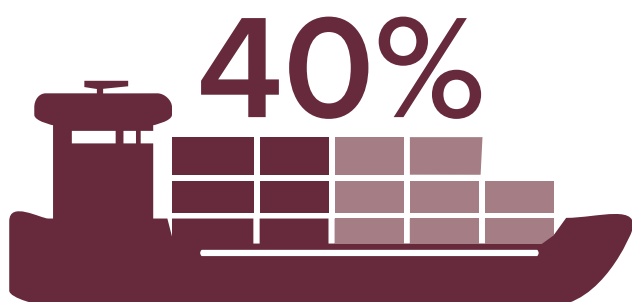
A small but high-profile trend to create personal services from cars (ridesharing), homes (rooftop solar, home sharing), possessions (renting or selling household goods and clothing), skills (providing one-off services to those in need, for example data entry, cleaning or furniture assembly), computing capacity (cryptocurrency mining) and capital (peer-to-peer money lending) has developed. There is potential to disrupt existing business models of established businesses.

Economy and productivity – snapshot

Our economy has increased by **130%** since 1991, following 28 years of uninterrupted growth ⁹⁴



64% of Australian Millennials would consider joining the gig economy to supplement full-time employment ⁹⁵



International trade is almost 40% of our economy ⁹⁶



Emerging industries for Australia include: higher education, food exports, tourism, rare earths and new minerals ⁹⁷



Australia ranks **18th in the world** for ease of doing business ⁹⁹

2.5 Economy and productivity

At a glance

Australia has had a record-breaking 28 years of uninterrupted growth. But the outlook is uncertain, with significant recent trade tensions, historically weak productivity and the apparent breakdown in historical relationships between unemployment and inflation.

This section looks at the opportunities arising from Asia's growth and the structural shifts in our own economy. It also considers trends that may create economic risk in the coming years:

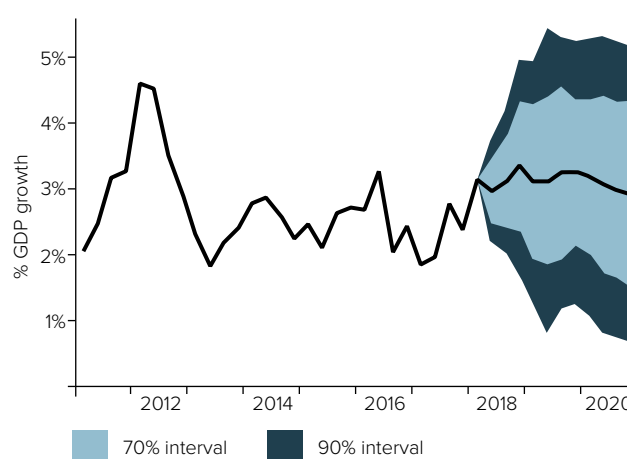
- Our growing population and economy will constrain budgets, but our net debt is relatively low.
- The cost of doing business in Australia is high due to labour, land, energy and regulatory costs.
- The digital economy is changing the way we work, consume and do business.
- Economic activity is urbanising, and the nature and location of work is changing.

Predicting economic growth is a challenge

Australia has experienced a record-breaking 28 years of uninterrupted economic growth. The size of the economy has increased by 130% in real terms since 1991, largely driven by our growing population and a significant export market for our natural resources.¹⁰⁰ Over this period, Australia has increased its global economic engagement, while avoiding the depth of economic crises that have affected other global economies by building on our industry strengths and our proximity to emerging Asian markets.

Australia's economic performance is measured by real GDP. Current real GDP is around \$1.8 trillion, placing Australia amongst the 20 largest economies in the world.¹⁰¹ The Australian Government has estimated that future average annual growth in GDP will slow to an average of 2.8% a year over the next 40 years, compared with 3.1% over the past 40 years.¹⁰² Similarly, the International Monetary Fund forecasts that Australia's GDP will grow at an average of 2.7% per year from 2019 to 2023, the highest for major advanced economies.¹⁰³ However, as Figure 10 shows, the future of Australia's economy is far from certain. Fluctuations in global political and economic conditions, and changes in Australia's own political, environmental and economic conditions, mean that there are widely varying possibilities for Australia's future economic performance.

Figure 10: GDP growth is difficult to forecast

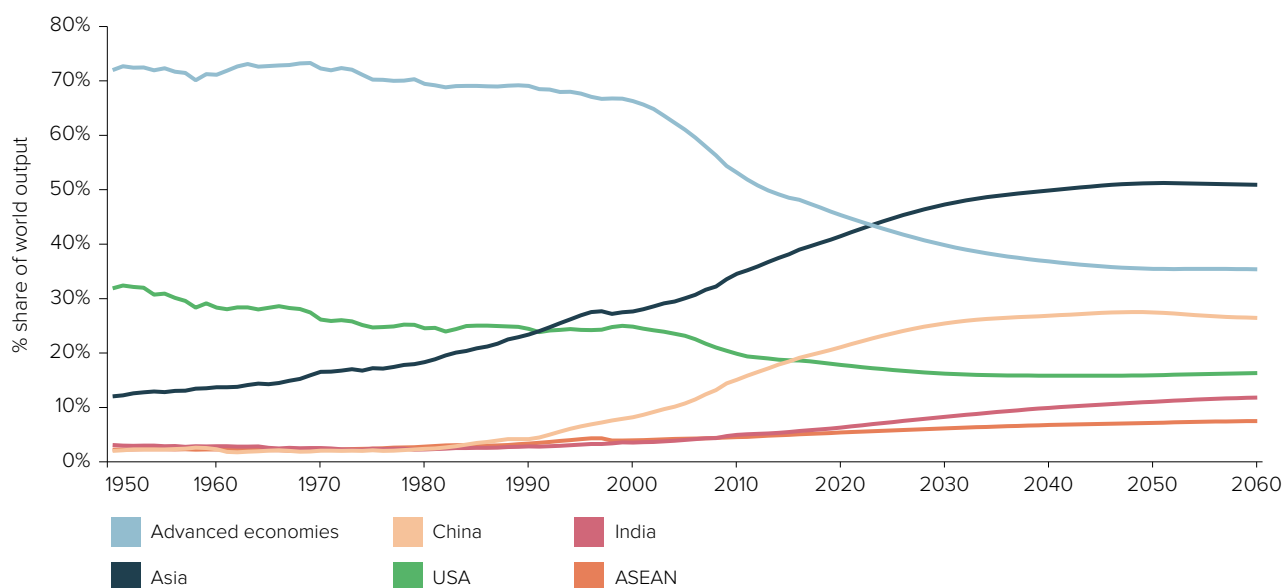


Note: Confidence intervals reflect RBA forecast errors since 1993.

Source: Reserve Bank of Australia (2018)¹⁰⁴

The growth of our Indo-Pacific neighbours presents opportunities

The performance of our economy relies on domestic and global factors. The increasing interconnectivity and globalisation of economic activity provides both opportunities and risks for the Australian economy. Globally, economic power is shifting from west to east, and from north to south, towards the Indo-Pacific region. While per-capita incomes across this region remain low, the region is leading the growth in the global economy (Figure 11). Growth is projected to grow in Asia by approximately 5.4% in 2019.¹⁰⁵

Figure 11: Asia's share of global economic output is projected to overtake advanced economies

Source: Australian Government (2015)¹⁰⁶

The Australian economy can capitalise on our proximity to the Indo-Pacific region as it experiences strong population and economic growth. By 2030, two-thirds of the world's middle class will live in this region, concentrated in China and India.¹⁰⁷ Australia's proximity to Asia provides the opportunity for Australians to benefit from the growth in Asian consumers through large proximate markets.

Countries in the Indo-Pacific are the major destinations for Australia's exports.¹⁰⁸ While minerals and fuels dominate Australia's export mix,¹⁰⁹ other goods and services provide opportunities for future diversification to cater for this region. Our manufacturing industry is advancing, improving the value of manufacturing exports, despite the volume of manufacturing exports declining. This is being supported by the growth of new technologies, such as sensors and robotics.

Demand in the Indo-Pacific for Australia's higher education, tourism and food exports (including bulk commodities such as wheat and valued-added produce such as seafood, meat, wine and cheese) remains high.¹¹⁰ Growth is also expected in emerging industries, such as rare earths and new minerals (for example, lithium).¹¹¹ Australia is seen as an increasingly attractive market to Indo-Pacific economies. For example, Chinese CEOs have identified Australia as the top market for growth outside their home market.¹¹²

However, Australia's export complexity (the diversity and ubiquity of products exported) is low, meaning the economy is highly specialised but also open to unforeseen changes in prices and demand.¹¹³ We should be alert to overdependence on single export markets.

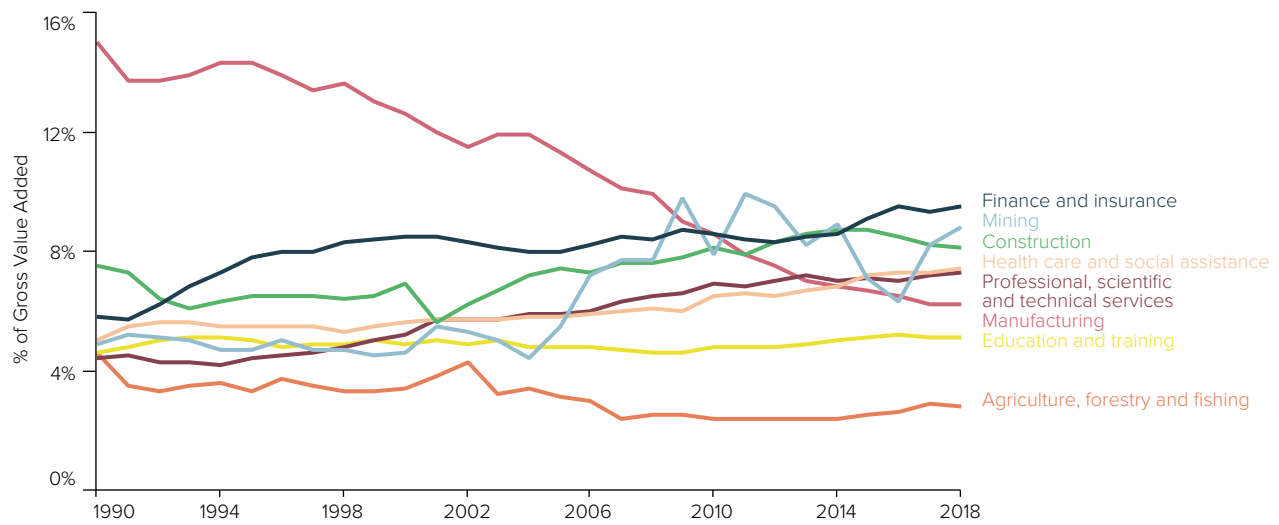
Achieving export diversification and growth will require Australia to change how goods are moved. Reducing freight costs is a challenge – freight costs have not fallen in 25 years, despite infrastructure investment and technological advancements.¹¹⁴ Australia may struggle to continue competing with lower-cost economies in Asia that are growing and maturing their own service industries.

Australia's economy is undergoing structural changes

Our economy is changing. Over the past three decades, our economy has transitioned from manufacturing to a substantial emphasis on services, which now account for 72% of Australia's GDP.¹¹⁵ The financial and insurance services sector contributed the most value to the economy in 2017–18 (Figure 12). Service industries such as health care and professional services accounted for most of the economy's growth in the same year. Future industry growth is expected across the services, renewable energy, health and aged-care sectors.

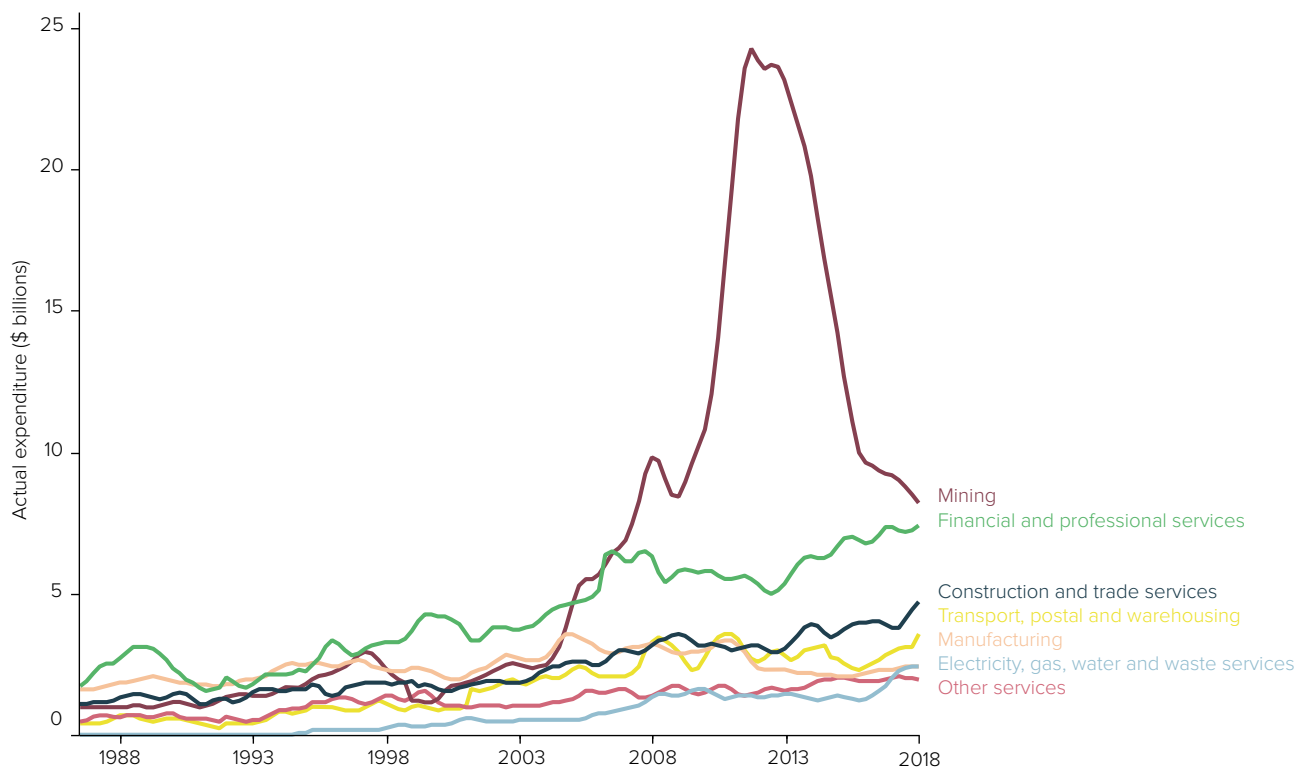
While the mining industry remains the dominant export industry, accounting for three of our top five exports, current trends show a tapering of business investment in mining, which will continue to decrease over the short term (Figure 13). Since the 2015 Audit, the mining industry has begun to shift from construction to production, which reduces job numbers but increases productivity. However, investment in additional mining capacity will not disappear, and there will still be strong demand for operational and maintenance works throughout the production phase.

Figure 12: Contribution to the economy from the manufacturing sector has declined dramatically over the past three decades



Source: Australian Bureau of Statistics (2018)¹⁶

Figure 13: Business investment in the mining industry is slowing as mining activity moves from construction to production phases



Source: Australian Bureau of Statistics (2019)¹⁷

Productivity growth is slowing

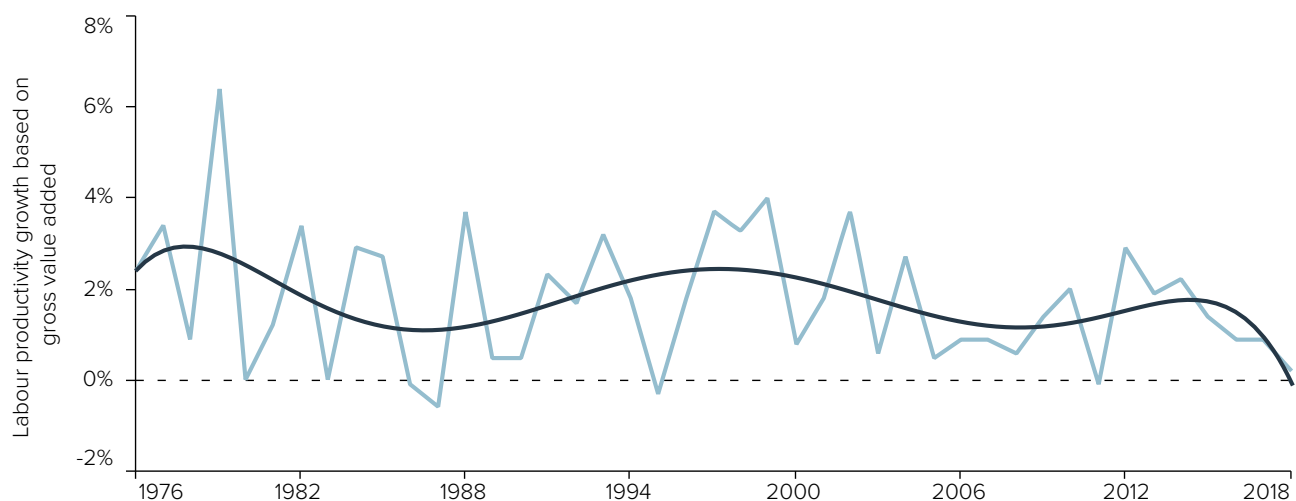
Economic growth is driven by three key components: productivity, population and labour-force participation. Productivity, the ratio of outputs to inputs, measures how efficiently an economy operates. Population and labour force participation are discussed in detail in section **2.6 Population and participation**.

Over the past 40 years, Australia's economic output per person has grown by 1.7%, and most of this has been driven by improvements in labour productivity.¹¹⁸ Labour productivity measures the output produced per unit of labour input. Since 2011, Australia's labour productivity has declined, particularly when compared to the historical trend of the previous few decades (Figure 14).¹¹⁹ It has also fallen behind internationally, with comparable countries such as the United States and New Zealand experiencing recent improvements.¹²⁰

The dynamics of labour productivity, however, are changing as technological efficiencies increase output per hour worked. For example, robotic technology can assist manufacturers to produce products more rapidly than before. Like many technological revolutions before today, this too will have implications for employment and participation in the economy.

Multifactor productivity is a broader indicator of productivity in the economy, measuring the ratio of output to a combined input of multiple factors, for example labour and capital.¹²¹ Overall, multifactor productivity growth has slowed – even turning negative – across most advanced economies in recent decades, including Australia (Figure 15). In Australia, this can be attributed to high capital investment (particularly in the mining industry) ahead of resulting economic output, and to a decline in agricultural production due to successive droughts.¹²²

Figure 14: Australia's labour productivity growth has declined in recent years, compared to the long-term trend



Source: Productivity Commission (2019)¹²³

Figure 15: Multifactor productivity growth has declined over the past two decades



Source: Australian Bureau of Statistics (2018)¹²⁴

Foreign investment should continue to contribute to Australia's productivity growth into the future. In 2018, Australia attracted US\$62 billion in foreign direct investment (FDI) inflows, an increase of almost 40% on 2017.¹²⁵ This performance places Australia in the top 10 global destinations for FDI. Already, around 10% of jobs in Australia rely on foreign investment, with the United States (27.5%), United Kingdom (14.7%), Belgium (9.3%) and Japan (6.7%) accounting for almost 60% of all investment.¹²⁶ This includes direct investment, such as buying a mine or portfolio investment in Australian-listed shares.¹²⁷

Budgets are facing fiscal constraints, but our net debt is relatively low

While government revenue has largely recovered from the GFC and the economy is projected to continue growing, budgets at all levels of government in Australia are facing a range of fiscal constraints into the future as our population grows and ages, and as greater investment is required to maintain our high quality of life.

As our population ages, the dependency ratio (the number of people of traditional working age (15-64) for every person over 65),¹²⁸ will decrease from 4.5 in 2014-15 to 3.2 in 2034-35.¹²⁹ This means younger generations will shoulder an increasing burden, as there will be fewer taxpayers to support funding for essential services, such as education and health care. Net overseas migration goes some way to alleviating this burden, largely because new migrants to Australia are generally younger than the average age of Australians.

Growth in recurrent expenditure, particularly for health care, will remain a challenge as our population ages. For example, Australian governments spent \$125 billion funding our healthcare system in 2016-17, and expenditure grew at an average annual rate of 4.6% over the decade from 2006-07 to 2016-17.¹³⁰ With an increasing number of people aged over 65 over coming decades, this rate is set to increase.

However, Australia's fiscal position compares favourably with other OECD countries. While net debt has increased over recent years and is much higher

than at the start of the 21st century, it is relatively low when compared with similar international economies (Figure 16).¹³¹ This means the Australian Government and many state governments are in a relatively stronger position to take on more debt to finance needed policy reform, services and infrastructure to support growth into the future.

The cost of doing business in Australia is high

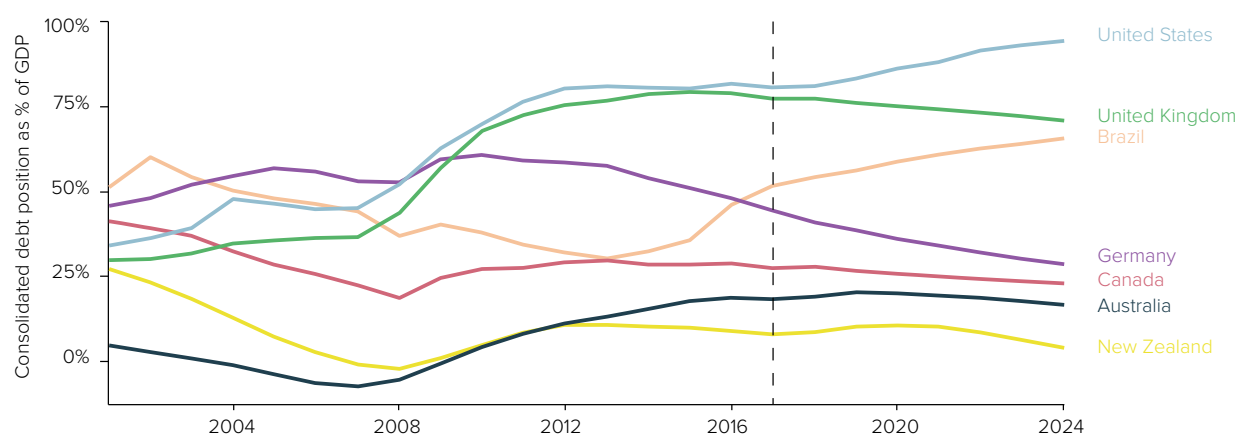
Australia ranks 17th in the world for ease of doing business, behind New Zealand (ranked most business friendly), the United States, United Kingdom, United Arab Emirates, Denmark and Sweden.¹³² We also rank behind our neighbours in Asia, such as Singapore, Hong Kong and China.

This is largely due to a combination of high labour costs with strong pay and workplace conditions, high land costs, high energy costs, and high regulatory costs, such as environmental standards.¹³³ Businesses are also increasingly using advanced technologies to improve efficiency and value which, while adding value, may also drive up costs. Matching labour skills to jobs is also becoming costly, at times requiring international migration to fill domestic skill shortages.

While environmental, workplace and other regulations are common both here and in other developed nations, and are important in maintaining the quality of life of Australians, when not efficiently and effectively applied they also place Australia at a competitive disadvantage. This has both economic and social impacts for Australia. Costs for consumers generally reflect the cost of doing business, and when business costs are high, there can be impacts for the cost of living, in particular for lower-income groups.

High costs can also reduce competitive advantage in the global trade of goods that can have economy-wide impacts. For example, the cost of freight has not reduced as rapidly as some other costs, in part due to the spatial size and distribution of Australian markets, and our distance from international markets. In cities, congestion adds to the cost of freight, whereas in regional and remote areas, distance between freight nodes is the primary cost generator.

Figure 16: Australia's net debt position is favourable compared to other international economies



Source: International Monetary Fund (2019)¹³⁴

The digital economy is changing the way we work, consume and do business

Australia's economy is increasingly digital. The digital economy is no longer contained to high tech companies and start-ups. It is transforming the way we do business and engage with business, and the way we consume, produce and market products and services. It is enabling people to more easily make money from their own – or share others' – assets, skills, space, capital and information.

The digital economy is already having wide-ranging impacts on our economy more broadly. Service industries, such as retail, are using new technologies to increase operational efficiencies, to gather and analyse more data from customers, and to personalise products and services. The manufacturing sector is using robotics and advanced modelling software to enable a transition from traditional manufacturing to advanced manufacturing, creating higher-value products for domestic use and international export. The tourism sector is using the digital economy to improve the experience of different stages of the travel experience, from online booking and information to virtual reality and digital augmentation.¹³⁵

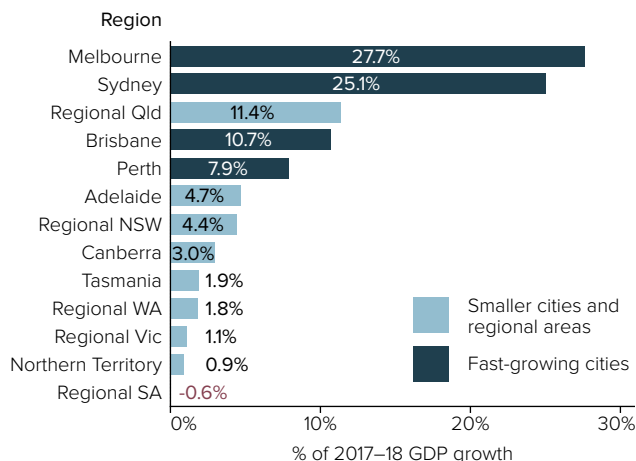
However, the digital economy also brings challenges, as some technologies deliver benefits but with unintended consequences. For example, electronic goods such as smartphones bring huge benefits to Australians and offer new opportunities to address modern challenges. They provide a platform for new tools to be developed that expand education, deliver health care and facilitate trade. However, each year, approximately 50 million tonnes of electronic and electrical waste (e-waste) are produced globally.¹³⁶ The potential for inputs to certain electronic products being sourced from unethical work environments also requires further investigation and resolution.¹³⁷

Regulatory structures are adapting to manage rapid technological change and disruption to existing markets, as we have seen with ridesharing. Changes to regulation are most effective when focused on customer outcomes such as safety, affordability and reliability rather than the technologies that will inevitably change.

Economic activity is urbanising

Structural changes to the economy have spatial implications, and Australia's economy is urbanising. Most of Australia's economic growth occurred in capital cities between 2000–01 and 2015–16 (70%), an average growth of 3.2% per year.¹³⁸ Growing industries are concentrating in fast-growing cities, particularly Sydney and Melbourne. Perth and Brisbane, while experiencing rapid growth during the mining boom, have seen slower growth in more recent years. Figure 17 shows the contribution to GDP growth by location in 2017–18.

Figure 17: Fast-growing cities are making a significant contribution to Australia's GDP growth



Source: SGS Economics and Planning (2018)¹³⁹

While our largest cities are growing, regional economies are in transition, particularly those that rely on agriculture and mining. Maintaining diversity in regional centres and building on existing economic foundations will be essential to the success of regional economies over the next 10–15 years. Many rural and remote economies are in decline as both people and economic activity move towards larger regional centres and cities. However, some rural and remote areas have shown economic growth as a result of mining construction and production, as we see in northern Australia.

Australia has a multi-tiered economy:

- Rapid economic growth and agglomeration in our **fast-growing cities** and their surrounding regions:
 - Greater Sydney, Wollongong and Newcastle
 - Greater Melbourne and Geelong
 - South East Queensland, including Greater Brisbane, the Gold Coast and Sunshine Coast
 - Perth and Peel.
- Moderate economic growth, consolidation and specialisation in **smaller cities** and towns with populations greater than 10,000, including Adelaide, Canberra and Hobart, and regional centres such as Cairns and Ballarat.
- Stabilising or declining economic growth in **rural and remote areas** with populations fewer than 10,000 people.

A fourth tier of the Australian economy includes areas that have seen **catalytic investment in rural and remote areas**, such as the Pilbara and Bowen Basin, to increase economic growth.



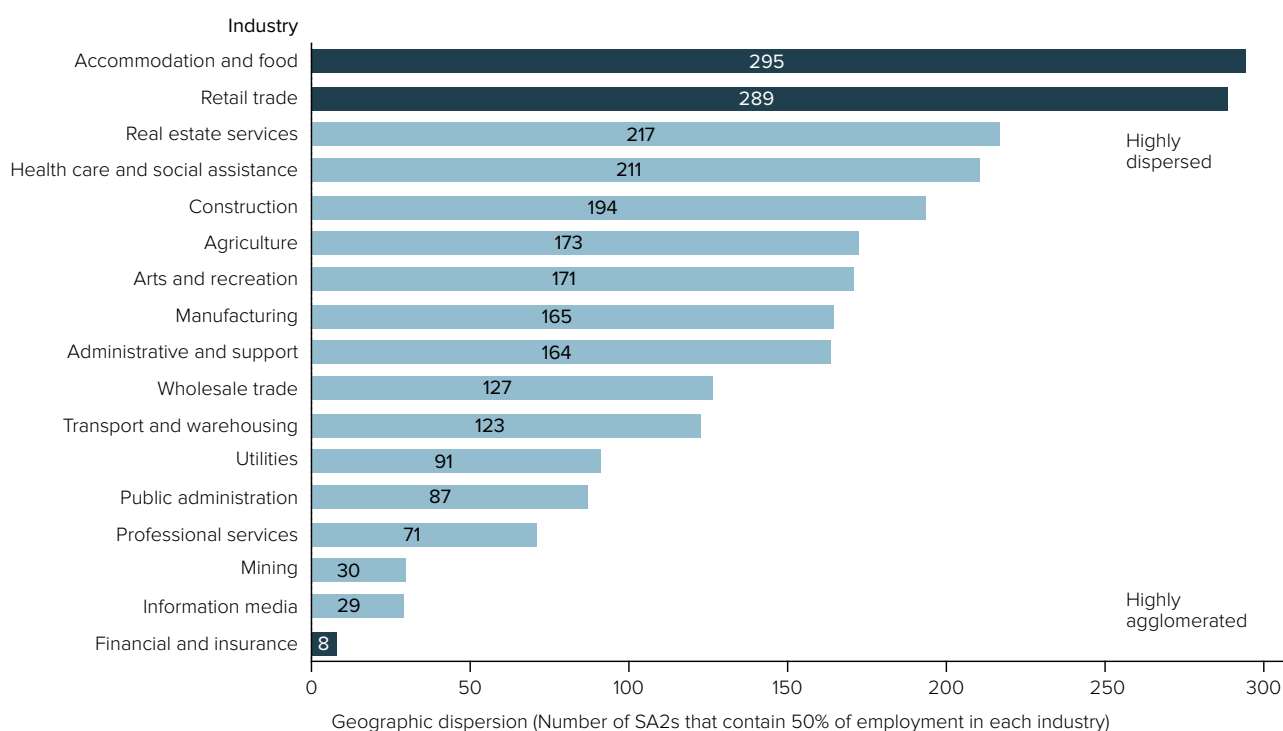
The nature and location of work is changing

As our economy urbanises, so too does the concentration of jobs across Australia, with most now located in our largest cities. While this broad trend is set to continue, employment sectors such as financial and professional services are more concentrated than sectors such as retail, accommodation and food services, and other services. For example, as Figure 18 shows, 50% of workers in the financial and insurance sectors work in just eight Statistical Area 2 (SA2) locations across Australia, largely in the inner areas of our fast-growing cities. Conversely,

industries like retail trade and accommodation and food services are much more dispersed across the country.

Industries are not spread evenly across Australia, meaning that different parts of Australia have different economic strengths and are exposed to different economic risks. Table 1 shows the three largest industries in terms of contribution to city GDP for selected regions across the country. Service industries and construction are driving economic growth in our fast-growing cities, while in smaller cities and regions, health care, construction and mining are supporting economic growth.

Figure 18: The location of financial and insurance services industries are highly agglomerated, whereas retail and accommodation industries are highly dispersed



Note: These values represent how many Statistical Areas 2 (SA2s) make up 50% of the national employed workforce in each industry, based on where jobs are located. A smaller number represents an industry which has much of its workforce working in a small number of locations. For instance, half of all jobs in the Financial and Insurance Services industry are located in various business districts within the five largest cities. An SA2 is a geographic area defined by the ABS, which represents a collection of small suburbs, or a large suburb. In the 2016 Census, there were 2,310 SA2s.¹⁴⁰

Source: Infrastructure Australia analysis of Australian Bureau of Statistics (2016)¹⁴¹

Table 1: Service industries contribute more to urban economies, while primary industries support regional economies

Top three industries contributing to GDP growth in 2017-18			
Fast-growing cities			
Sydney	Construction	Financial and insurance services	Professional services
Melbourne	Financial and insurance services	Health care and social assistance	Construction
Brisbane	Construction	Professional services	Health care and social assistance
Perth	Health care and social assistance	Financing and insurance services	Manufacturing
Smaller cities			
Adelaide	Health care and social assistance	Construction	Professional services
Canberra	Professional services	Health care and social assistance	Administrative services
Regional Australia			
Regional Qld	Utilities	Mining	Manufacturing
Regional Vic	Health care and social assistance	Construction	Education
Regional WA	Mining	Professional services	Construction

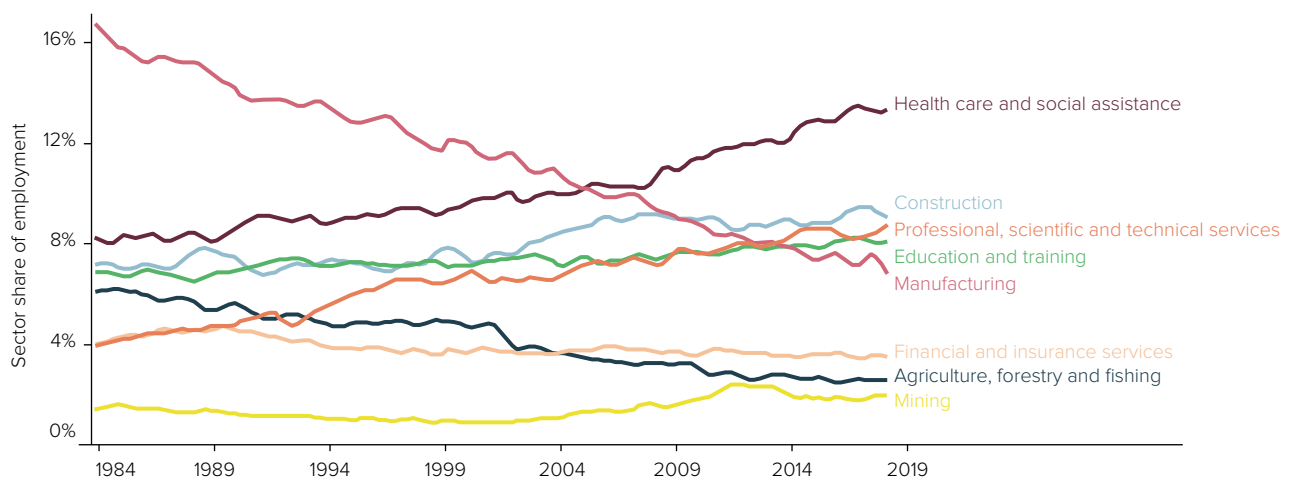
Source: SGS Economics and Planning (2018)⁴²

The relationship between economic growth and employment growth is also changing. As digital technologies and automation enable greater labour productivity, sectors that produce more economic growth are not necessarily employing more people to achieve it. For example, employment in the manufacturing industry is declining as this sector

transitions towards producing fewer but higher value advanced manufacturing products, supported by new technologies. At the same time, employment is increasing in services sectors such as health care, which is expanding to support population growth and an ageing population (Figure 19).



Figure 19: Employment in manufacturing industries is declining, but health care and social services industries are expanding



Source: Australian Bureau of Statistics (2019)¹⁴³

Population and participation – snapshot

National population growth in 2019 is

1.8%
per annum,
0.3% higher than
2015 Audit ¹⁴⁴



Australia has grown by over

**1.5 million
people**
since the last Audit ¹⁴⁵

Between 2008 and 2018

71.6%
of population growth occurred
in our fast-growing cities ¹⁴⁶



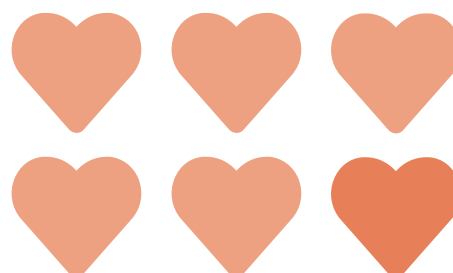
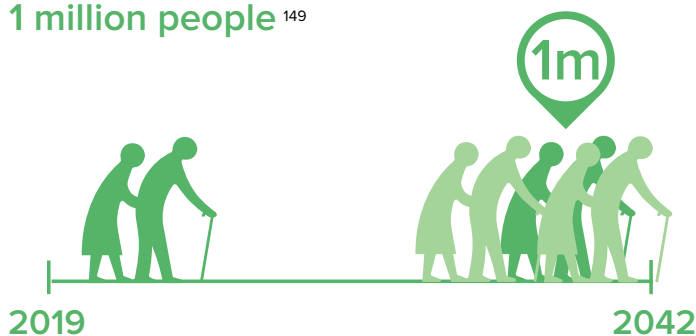
Australia ranks

15th
in the world for
female participation
in the workforce ¹⁴⁷



Number of **single
person households** will
increase by over
60% to 2036 ¹⁴⁸

By 2042, the number of Australians aged 85 years and over is projected to **double to over 1 million people** ¹⁴⁹



Australia has the **6th highest**
life expectancy in the world ¹⁵⁰

2.6 Population and participation

At a glance

Australia has a small but fast-growing population compared to other nations. Overseas migration largely drives this growth. This section looks at some of these key population changes:

- Our living spaces are becoming denser and more urban, particularly in fast-growing cities. Smaller cities and regional centres are also growing, but some rural and remote areas face decline.
- We are more diverse, and our household makeup is changing as people adapt to cost-of-living pressures. This brings both challenges and opportunities.
- Workforce participation is steady overall, but increasing for women. Our ageing population poses challenges, but it also creates economic opportunities.

Australia's population is growing

Australia has a small but rapidly growing population by international comparison. At 25 million people, equivalent to the city of Shanghai, we are the 53rd largest country in the world,¹⁵¹ but growing at a faster rate than other developed nations (1.8% per annum, compared to the global average of just over 1.5%).¹⁵² Since the 2015 Audit, Australia has grown by over 1.4 million people.¹⁵³

While population growth delivers significant benefits, growth into the future will also present challenges. Australia will need to deal effectively with these challenges if it is to maintain its high quality of life and economic productivity.

The ABS develops population projections using high, medium and low growth scenarios to estimate Australia's possible future population. The projections are based on assumed demographic changes in the population, but do not include other factors such as changes to the economy or community preferences.

The Series B scenario reflects current trends in births, deaths and migration – business-as-usual – while Series A and Series C are based on higher and lower assumptions, respectively, for each component of population growth. Over the next 15 years, Australia's population is projected to grow to between 30.3 and 32.7 million people (Figure 20).

While population projections provide us with an idea of potential growth in the future based on current trends, predicting how and where Australia will grow is an inexact science. State and territory governments use ABS projections to develop their own projections at smaller geographies, such as the local government level. At times different departments within state and territory governments create their own projections. Discrepancies in projected population sizes and the assumptions underpinning projections can create uncertainty for communities, and for land-use and infrastructure planning. This can create misalignment in decision making.

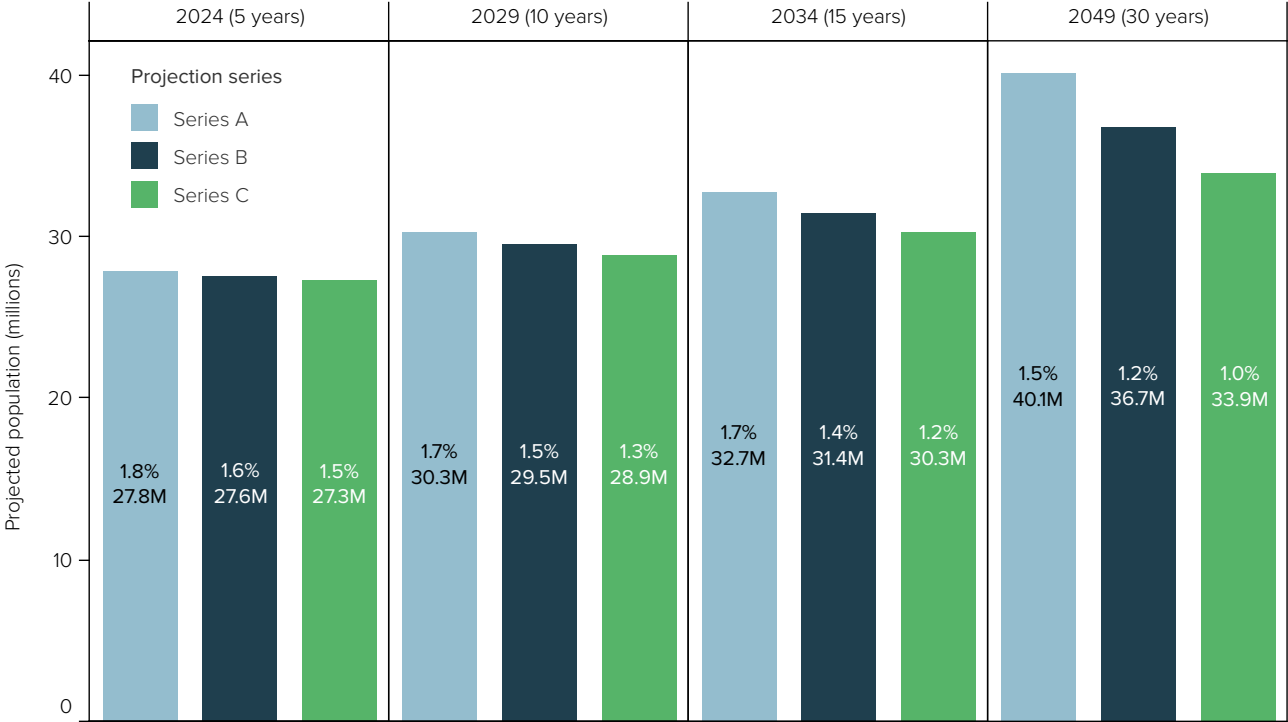
Australia's population composition

The size of Australia's population is determined by the interrelated components that make up any population: births, deaths and migration.

- **Births:** Australia's fertility rates have dropped slightly over the past 20 years, from around two births per woman, to 1.7 births per woman.¹⁵⁴
- **Deaths:** Average life expectancy is increasing in Australia, largely due to advancements in the quality of and access to health care. Australia has one of the longest life expectancies in the world, ranked sixth by the United Nations at 83.15 years.¹⁵⁵
- **Migration:** Net overseas migration varies according to government policy. Both permanent (for example, family and skilled) and temporary (for example, international students and temporary skilled) visa migrants contribute to changes in Australia's population. In 2016-17, Asia accounted for 56% of Australia's migrant intake.¹⁵⁶ People from India and England were the largest sources for skilled visas, China and England for family visas, and Iraq and Afghanistan for humanitarian visas. Temporary visa holders primarily come from New Zealand (special visa category), China (student visa), India (temporary skilled work) and South Korea (working holiday visa).¹⁵⁷



Figure 20: Australia’s population is projected to reach at least 30.3 million people within 15 years



Note: Percentages refer to compound annual population growth rates from 2019.

Source: Australian Bureau of Statistics (2018)⁵⁸

Predicting how we will grow is an inexact science

Estimating the size, composition and location of Australia's future population is a challenge. Historical projections show that actual growth can vary according to a variety of changes, including economic performance, government policies and changes in community preferences. At a national level, international migration plays a significant role in determining population growth. Immigration levels can vary significantly based on government policy and political sentiment.

Projections have been wrong in the past. For example, Australia reached a total population of 25 million people in mid-2018, a milestone that was projected in 1998 to occur in the second half of the 21st century (Figure 21). There can be significant consequences for land-use planning, infrastructure and service delivery from incorrect assumptions for growth.

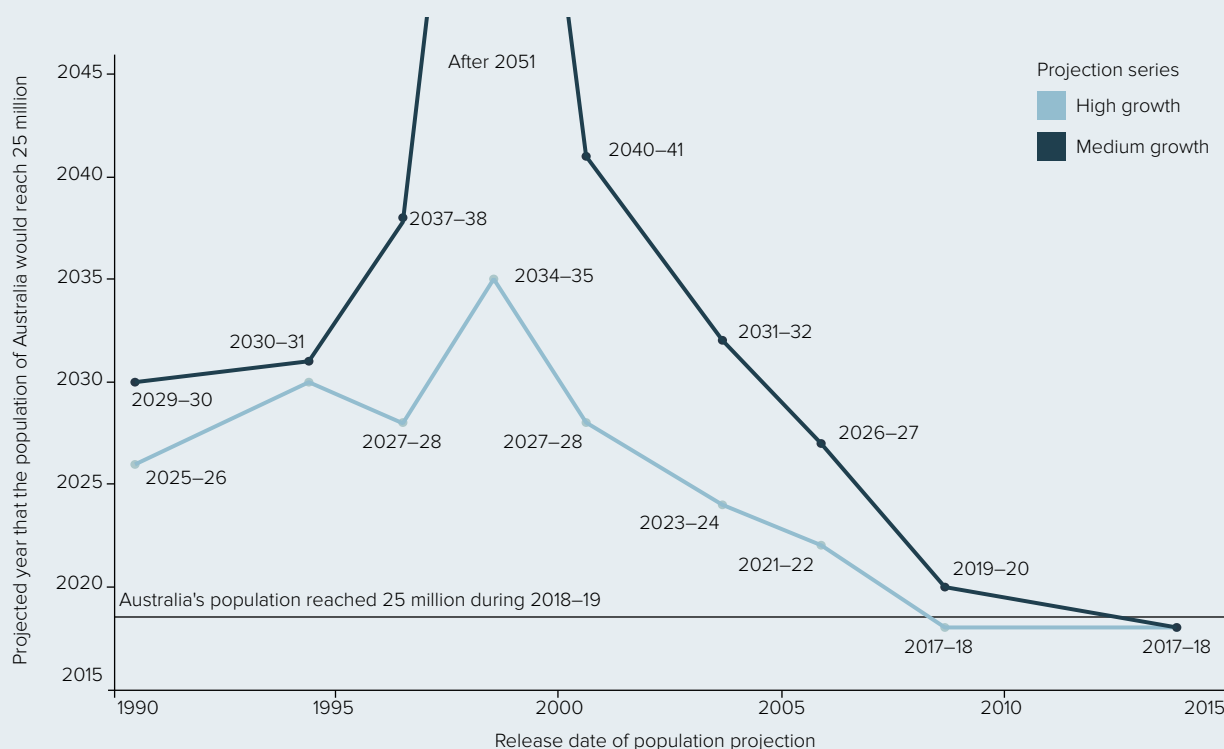
Estimating population growth for small geographies faces similar challenges. Where people live within Australia is influenced by factors such as economic growth and job availability, affordability and lifestyle preferences. These factors can shift over time, meaning people can

move to or away from places before projections (and the supporting services and infrastructure they influence) can catch up.

For example, the 2013 ABS population projections underestimated Melbourne's population in 2016 by 2.59%. The city grew faster due to stronger than expected economic growth and larger than expected internal migration from regional Victoria and other states. These projections also overestimated Perth's 2016 population by over 7%, as they were developed while the mining construction boom was peaking and assumed continuing growth levels.¹⁵⁹

One approach which may help to reduce uncertainty in estimating future population growth is using forecasting (developing potential scenarios for the future based on a number of potential factors), rather than projecting (extrapolating from past or current trends) tools. These can help governments to create different growth pathways and determine the required responses from government in terms of policies and investment.

Figure 21: Historical population projections overestimated how long it would take for Australia's population to reach 25 million



Source: Infrastructure Australia analysis of Australian Bureau of Statistics (1990, 1994, 1996, 1998, 2000, 2003, 2005, 2008, 2013)¹⁶⁰

Our population is urbanising and densifying

While Australia is a large continent with a relatively small population, our population distribution is highly concentrated. While people live across many parts of the country, from the tip of Cape York in the north east, to Augusta in the south west, the majority of Australia's population lives in urban areas, particularly in fast-growing cities. Sydney and Melbourne alone account for around 40% of the Australian population, and this is growing.¹⁶¹ As Table 2 shows, between 2008 and 2018, 72% of population growth occurred in fast-growing cities. This means that around 60% (14.7 million people) of Australians live in these four cities today. Over the Audit period to 2034, 77% of our population growth is projected to occur in our four fast-growing cities, and 82% of growth is projected to occur across our eight capital cities.¹⁶²

This is not an isolated phenomenon, rather it is a global trend. Across the world, developed countries are rapidly urbanising, driven by economic and social shifts and preferences. As more jobs locate in cities, more people move to cities, and as more people

locate in cities, so too are businesses attracted to larger labour markets in cities.

People moving to cities tend to be young, with the median age of people living in capital cities being 35.9 years, compared to the national median age of 37.3 years.¹⁶³ Migration has also played an important role in the growth of our cities. In 2016-17, over 75% of net overseas arrivals settled in Sydney and Melbourne.¹⁶⁴ As our population ages, young, skilled migrants will underpin continued economic success.¹⁶⁵ Despite this growth, Australia's cities have some of the lowest densities amongst large cities.

However, within fast-growing cities, populations concentrate around transport and job centres (supporting by planning laws and policies), and densification is increasing (Figure 22). As these cities grow, further densification can occur to accommodate new people and adjust to the geography of new economic structures, transforming them from suburbanised to urbanised. This will create new patterns of living, travel and demand for services, placing pressure on existing infrastructure networks.

Table 2: The majority of Australia's population growth is occurring in major cities

	2008	% of 2008 population	2018	% of 2018 population	2008–2018 change	% of national growth
Fast-growing cities ^a	12,040,000	57%	14,720,000	59%	2,680,000	72%
Smaller cities and regional centres ^b	6,340,000	30%	7,220,000	29%	890,000	24%
Rural and remote ^c	2,880,000	14%	3,060,000	12%	180,000	5%
Australia	21,250,000		24,990,000		3,740,000	

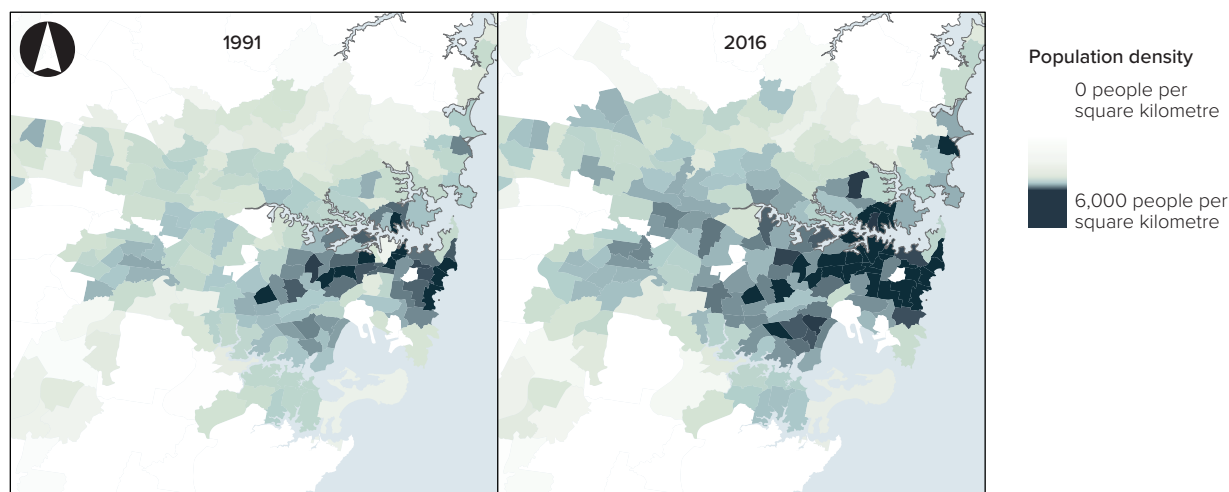
^a Population of the four largest Greater Capital City Statistical Areas (GCCSAs).

^b Population of all Significant Urban Areas (SUAs) not located within the four largest GCCSAs (excludes 8 SUAs).

^c Australia's population minus the first two totals.

Source: Australian Bureau of Statistics (2019)¹⁶⁶

Figure 22: Residential population density has increased in inner Sydney between 1991 and 2016



Source: Australian Bureau of Statistics (2017)¹⁶⁷

Smaller cities and regional centres are growing, but rural communities and remote areas are declining

Beyond our fast-growing cities, populations across smaller cities, regional centres, rural communities and remote areas are shifting. Smaller cities and regional centres are growing, at times at the expense of rural communities or remote towns. This reflects changes to regional and rural economies as industries decline, the environment changes, and personal preferences shift, including the move of young people to larger towns and cities to seek job opportunities. Figure 23 shows this trend of population decline in very remote areas since 2012, across all states and territories except Tasmania. This may also reflect changes in the way in which governments are providing services. For example, in New South Wales, a 'hub and spoke' service delivery model is galvanising a shift towards regional centres as 'service centres' across the state. Services provided by the private sector at a local level are also changing. For example, there are fewer bank branches in small towns today than there were one or two decades ago, enabled in large part by the growth of online banking services.

We are more diverse and living in different ways

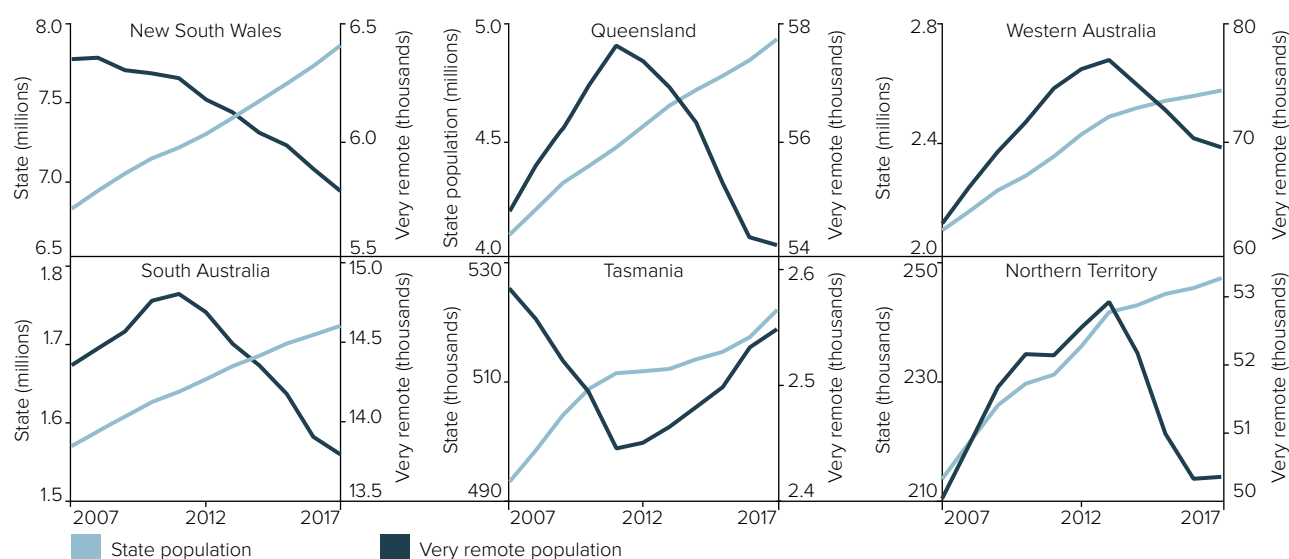
As Australia grows, so too will our cultural and linguistic diversity. Effectively half of Australia's population today was born overseas or has a parent who was born overseas. Moreover, we have the most diversified workforce by country of origin of any developed nation, save Switzerland. Cultural

diversity is an economic and social strength for Australia, introducing different ideas, capabilities and experience.¹⁶⁸ Increasing diversity will require governments and communities to meet and celebrate different needs, including foreign language services, different housing and family structures, and different lifestyles and ways of living.

The demographic makeup of our population is also changing. In 2042, it is expected that the percentage of people aged over 65 will increase from 15.4% in 2017 to between 18-20% (around 2.5 to 3 million people).¹⁶⁹ The median age of Australia's population was 37.2 years in 2017.¹⁷⁰ This is projected to increase to between 39.5 years and 43.0 years by 2066.¹⁷¹ While an ageing population will affect the economic and social structure of Australian society, our largest cohort by population over the short term is in fact the millennial generation (those aged between 13 and 38 in 2019).¹⁷²

Household structures are also changing, with the total number of households set to increase by approximately 50% by 2036, and single-person households expected to experience the greatest percentage increase (61-65%) over this period.¹⁷³ However, multiple family and group households are expected to also increase, as cost-of-living pressures including housing affordability result in more adult children living at home longer, people sharing houses for longer, or older relatives living with their children later in life. These changes have implications for land-use planning, as people require different types and sizes of homes, across different locations, throughout their lives.

Figure 23: Population in very remote areas have declined since 2012 across Australia, except in Tasmania



Note: This is drawn from the ABS's Remoteness Structure, which does not have very remote areas in Victoria or the Australian Capital Territory.¹⁷⁴

Source: Australian Bureau of Statistics (2018)¹⁷⁵

Labour force participation is relatively stable, but increasing for women and older people

Australia's labour force participation rate has remained relatively stable over the past decade, with an average of 65% of the working-age population either working or looking for work.¹⁷⁶ This compares favourably to the OECD average and United States, but is lower than Canada, the United Kingdom, and New Zealand.¹⁷⁷

In 2018, Australia's employment rate was close to the highest on record, and unemployment was at a six-year low, reflecting Australia's continuing economic growth.¹⁷⁸ Over the past three decades, participation rates have remained steady for all age groups except for those aged over 55, where participation has grown significantly.¹⁷⁹ While an ageing population will slow labour force growth slightly, this trend is likely to continue as older people stay in the workforce longer.

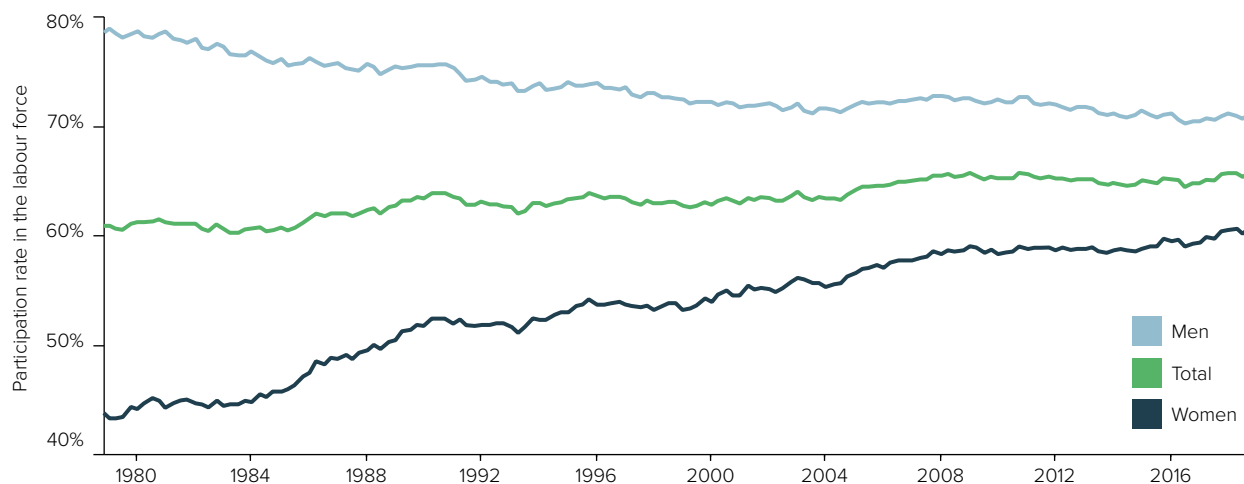
The digitisation of the economy and the emergence of sharing markets are creating new environments for workers, bringing both flexibility and uncertainty. The growth of the gig economy has implications for job security and cost of living pressures, as it relies on contracting to supply labour. Independent contractors now make up around 12% of Australia's workforce.¹⁸⁰

This casualisation of the workforce, and associated job instability, has contributed to a slight rise in underemployment (people who are employed but wish to work more hours) across Australia over the past 5 years.¹⁸¹ The implications of such arrangements for workers' rights to fair pay have been legally challenged, and current Australian labour regulatory structures are yet to fully adjust to take growing categories of work into account.¹⁸² This could affect the longer-term retirement income system for people who spend large portions of their career working in these types of jobs.¹⁸³

Digital literacy is now crucial for engaging in the workforce, and in the economy. The Australian Government predicts that 90% of all Australian workers will require some level of digital skills within the next five years.¹⁸⁴ However, while technology is expected to make workers more productive, the average number of hours Australians work is projected to remain steady over coming decades, falling only slightly. This is expected to be driven largely by the population ageing, as more people aged over 60 remain in the workforce but work fewer hours.¹⁸⁵

For women, participation rates have also increased over the past three decades (Figure 24), and are expected to continue improving. However, rates are still lower than those for men, and lower than comparative countries. We sit in the middle of the rankings for female participation rates across OECD countries, behind a number of Scandinavian and European countries, and New Zealand and Canada.¹⁸⁶ At the same time, the gender pay gap reached its lowest point over the past two decades in November 2018 (14%), it has hovered between 14% and 19% over this period.¹⁸⁷ Gender segregation in the workforce is also stark in Australia, compared to other OECD nations, over 50% of private sector organisations in Australia are either female or male dominated.¹⁸⁸

Figure 24: Australia's female participation rate has increased, while total participation has plateaued



Note: Participation rate refers to the proportion of civilian population aged 15 years and over who are active in the labour force: either employed, had actively looked for work, or were waiting to start a new job.

Source: Australian Bureau of Statistics (2019)¹⁸⁹



Our ageing population poses economic and social challenges

Australia's population is ageing, as advancements in health care mean people are living longer, healthier lives. The proportion of people aged over 65 is currently 16% (or around 4 million people). By 2034, this will grow to around 18% (or 5.9 million people).¹⁹⁰ This will include almost a million people aged 85 and over.¹⁹¹

Our ageing population will place increasing pressure on social services and infrastructure. In particular, we will see increasing demand for health care, aged care and geriatric medical specialisation, and other social services to provide greater social network supports, especially for older people living alone. However, we are not ageing as quickly as other developed nations, largely due to the arrival of overseas migrants who are on average younger than the median Australian age.¹⁹²

Increasing dependency ratios will place pressure on the economy. Despite older people already staying in the workforce longer than previous generations, labour force participation will slow and place downward pressure on taxation revenue.¹⁹³

Over the next decade, the ageing population is projected to reduce Australia's annual real growth in revenue by 0.4 percentage points, and add 0.3 percentage points in spending, equating to an annual cost to the budget, in real terms, of around \$36 billion by 2028–29. This is larger than the projected cost of Medicare in that same year.¹⁹⁴

However, an ageing population also presents opportunities, particularly as the health and aged-care sectors expand to meet demand. As employment in these sectors grows, Australia is well placed to lead technological and service-provision innovation in healthcare, geriatric medicine, aged care and end of life care.

Technology and data – snapshot

Just over
90%

of Australians
own a smartphone
(world average
should reach
90% by 2036) ¹⁹⁵



Q **3.9 million**

Google searches globally per minute (2018) ¹⁹⁶



Key technologies in the near term:

5G, artificial intelligence, drones, automated vehicles, genomics, virtual and augmented reality, and the Internet of Things ¹⁹⁷

2.5 quintillion bytes

(2,500,000,000,000,000,000 bytes)

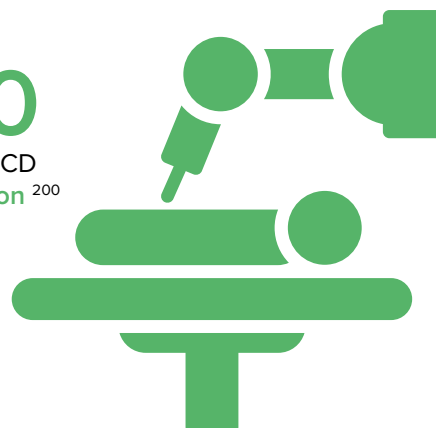
of data created per day ¹⁹⁸



of jobs to be
impacted by
computerisation
over next
20 years ¹⁹⁹

1 in 10

jobs across the OECD
at risk of automation ²⁰⁰



2.7 Technology and data

At a glance

Technological change offers profound opportunities for Australia. It can improve lifestyles, offer better access to services, enhance efficiency and create new industries.

This section looks at rates of technology uptake. These vary by location, and some regions suffer from slow internet that makes digital services less attractive. Advances are often prompted by cost savings rather than community preferences. In addition, our investment in research and development has declined as we struggle to leverage our technological expertise.

The section also looks at the challenges we face in:

- developing new regulations and controls
- providing equitable and affordable access for everyone
- balancing our growth against privacy and security needs.

Fast-changing technology is shaping our society

Technology is deeply embedded in modern Australian life. We rely on different forms of technology every day to communicate and share information, to learn, to travel, to access services, to do business and pay for things, and for entertainment.

While technology has underpinned substantial progress over the past century, what makes today's environment different is the speed of change and the level of disruption technology is creating in the way we live and work. The pace and scale of technological change today provides profound opportunities for Australia – to improve lifestyles, provide better access to services, enhance efficiency and create new industries. However, technological advancements and data generation also create new challenges around control and privacy of data, and raise questions around how to ensure the benefits of technological advancement are available to all.

Technology will continue to shape the way Australians live and work in a number of ways, including:

- **Work and skills:** Projections indicate that one in ten jobs across the OECD is at high risk of automation.²⁰¹ In Australia, as many as 44% of jobs could be affected by computerisation over the next 20 years.²⁰² Autonomous technology such as facial recognition software, chat bots that answer phone calls and autonomous robots that replace labour-intensive or repetitive jobs, will change the roles of workers and nature of work.

These advancements will create new industries and jobs in areas such as specialised data analysis and advanced manufacturing engineering, and will see certain jobs carried out more safely or precisely. Video conferencing technology advancements could enable further shifts towards

telecommuting and inter-office collaboration, and affect existing commuting and business travel patterns.

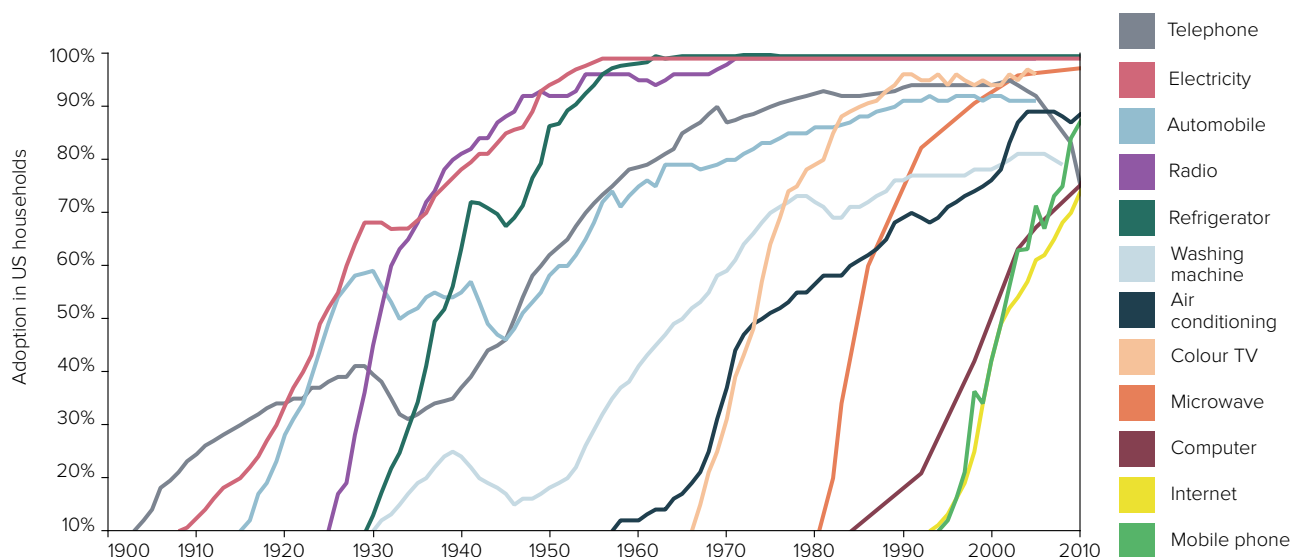
- **Media and public dialogue:** Across Australia, newspapers, TV and radio are increasingly produced in a few metropolitan areas and the investment in traditional newsgathering and programming has decreased as online media absorb the spending of advertisers.

Online media is disrupting the way news and journalistic content is aggregated and distributed. This can often further fragment audiences as news production responds to community preferences for more customised content, resulting in people receiving more curated information.

- **Social behaviour and relationships:** Improved digital connections to other people, forms of entertainment and information are changing how we interact with one another. Face-to-face interactions, while still valued, are becoming less common than digital communication, and new languages and types of interactions are evolving through the increasing use of social media.

Rates of technological uptake are accelerating

The rate of uptake in new consumer technologies has increased dramatically over the past century (Figure 25). This has been driven by increasing numbers of researchers and knowledge workers in more fields, greater and faster cross-links between different fields with a transfer of ideas and techniques, and greater and faster international transfer of ideas converted to products and services across global markets.²⁰³ When the 2015 Audit was released, the world was on the cusp of artificial intelligence and advanced manufacturing technologies. For example, Apple introduced multi-pressure sensors in its iPhone technology, and connectivity between cars began to increase.

Figure 25: Technology uptake rates have increased dramatically since the 1990s

Source: Ritchie and Roser (2019)²⁰⁴

Uptake of new technology in Australia is varied

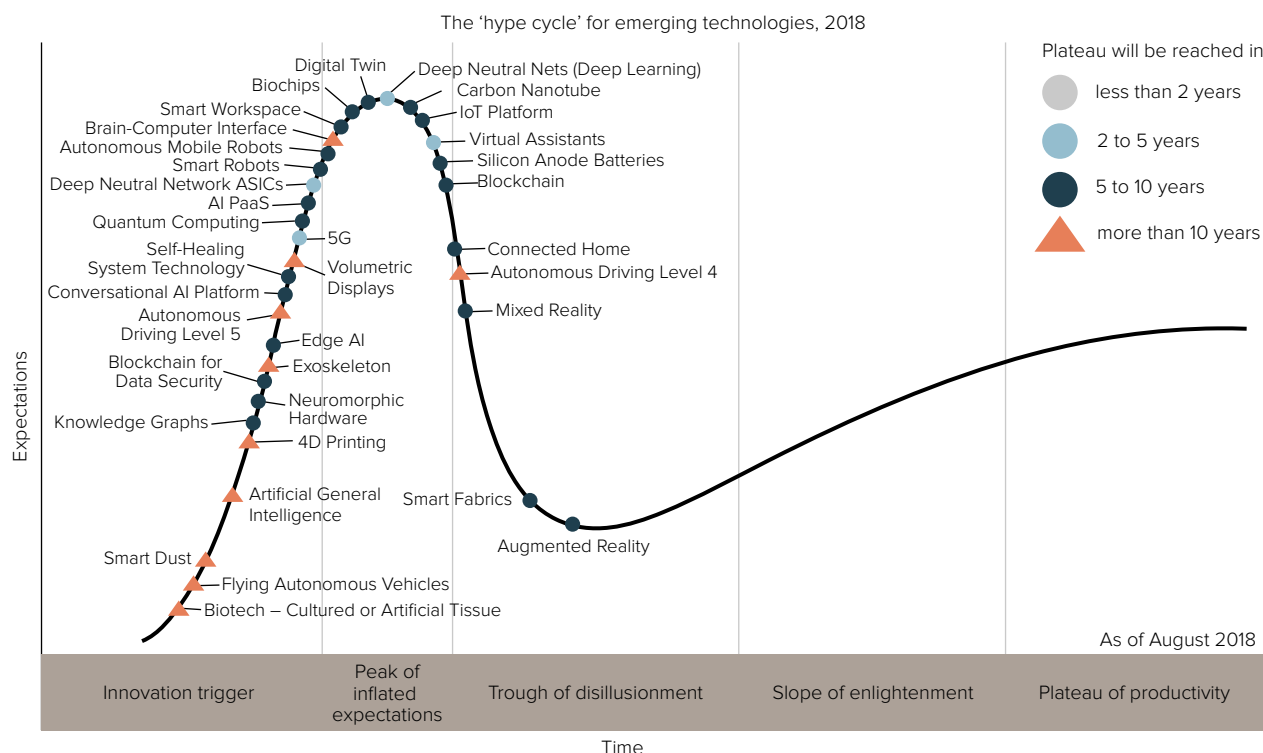
While the global rate of technological adoption has increased, Australians have not embraced all new technologies in the same way. Uptake has been relatively rapid and pervasive in Australia for:

- Smartphones: just over 90% of Australians own a smartphone, while the rest of the world should reach 90% by 2023.²⁰⁵
- Social media: 80% of Australian households with internet access use social media.²⁰⁶
- Solar panels: more than 2 million or 20% of all homes now have rooftop solar,²⁰⁷ making it likely to be the highest proportion of households in the world.²⁰⁸

Infrastructure has a large enabling role to play in the adoption of new technology and services. Australia ranked a poor 57th in the world in June 2019 on

fixed internet speeds, behind North America, most of Europe and parts of Asia.²⁰⁹ New Zealand's mean download speed is more than double that of Australia.²¹⁰ While the current roll out of the National Broadband Network (nbn) is improving speeds, slower internet speeds affect productivity. In 2017, small businesses located in regions with nbn connectivity saw revenue grow by two-thirds and employment grow by one-third more than businesses in regions without the nbn.²¹¹

Differences in technology uptake rates are often linked to community expectations of the benefits it can deliver. Even successful technologies with high expectations can be met with disillusionment and reality checks as implementation and promise are delayed, as represented in the 'hype cycle' in Figure 26. New technologies can also result in higher costs. For example, technological advancements in the health sector can improve health outcomes or health infrastructure efficiency, but drive up costs for both governments and patients.

Figure 26: Expectations for new technologies can peak and troughSource: Gartner (2018)²¹²

Technological opportunities for Australia are varied

Future technology sectors of opportunity for Australia include higher-speed 5G mobile phone networks (around 50% of Australians expect to adopt 5G technology over the next five years),²¹³ fuzzy logic and artificial intelligence (AI), drones, automated vehicles, genomics, virtual and augmented reality, and the Internet of Things (IoT).²¹⁴ Around 15% of people currently own connected and smart home devices, however a further 30% expect to be using these technologies within the next five years.²¹⁵

Many of the key emerging technologies set to transform Australia will not be immediately obvious to Australians today. Community research conducted by Infrastructure Australia indicates that around one-quarter of Australians are still unfamiliar with technologies such as digital education, telehealth and on-demand transport.²¹⁶

Australia's future technologies

5G mobile technology is an advanced mobile network technology focused on mobile data and connectivity. It will provide faster network speeds, lower latency and more simultaneous connections than current 3G and 4G networks available in Australia today.

Fuzzy logic is the pre-cursor to artificial intelligence. It uses computer models to identify patterns and make simple decisions based on binary variables. For example, sensors connected to a heating or cooling device may use fuzzy logic to determine the temperature in a room and adjust heating or cooling settings according to rules for temperature ranges.

Artificial intelligence uses computer models that are able to perform tasks on their own, without human direction. AI uses otherwise 'human intelligence' skills such as visual perception, speech recognition, decision making and language translation.

Drones are unmanned vehicles, navigated remotely using GPS tracking systems. Drones are used for a number of different purposes, including photography and videography in inaccessible places, logistics and transportation, defence purposes, and surveillance and monitoring.

Automated vehicles are vehicles capable of sensing their environment and moving without human input. Examples include self-driving cars and driverless trains. They use sensors, such as radar, sonar, GPS and odometry, to interpret their surroundings and navigate.

Connected vehicles are able to communicate between vehicles and other connected devices, including buildings, infrastructure and personal devices. This enables them to move more efficiently together and to communicate with their surrounding environment.

Genomics is the biological study of genomes – an organism's complete set of DNA. Genome mapping has facilitated greater understanding of human and animal DNA and complex organs such as the brain. For example, it allows doctors to better understand genetic variation, hereditary conditions, and the gene responses to certain diseases and drugs.

Virtual reality is used for purposes including entertainment and training purposes to create an immersive artificial version of real life or imagined reality, using computer modelling and often requiring a headset. For example, an increasing number of video games are using virtual-reality

technology to create improved experiences for players.

Augmented reality overlays computer-generated enhancements to a real space or thing, making it more informative or engaging. For example in the retail sector, smartphone apps which allow customers to digitally 'try on' eye glasses using camera face-mapping technology, while others allow people to digitally 'place' new furniture into a room in their home.

Internet of Things is a collection of connected devices, particularly sensors, which enable everyday objects to connect through the internet. For example, **connected and smart home devices** (such as lighting, heating and cooling, TVs and speakers) can be controlled remotely or set to turn off and on at certain times, or change under certain conditions. Wearable technology includes smart watches and other devices that can track movement and other health indicators. For built environments, the IoT can enhance the operations of objects and services, such as predictive and on-demand maintenance of infrastructure assets and networks.

Digital education uses technology to enhance learning experiences. It includes simple technologies such as e-textbooks and classroom technology (smart boards), and more advanced technologies, such as gamification, virtual reality and augmented reality.

Telehealth uses telecommunication technology to deliver health care, information and education remotely. It is especially valuable for people living in regional, rural and remote areas without proximity to speciality healthcare services, or an inability to travel to receive care.

On-demand transport services use telecommunications technology, generally through smartphone apps, to provide flexible public transport services based on demand, rather than on fixed timetables and routes. For example, a passenger can request a vehicle to pick them up from their home and take them to a nearby train station.

Quantum computing is reimagining the way computing works based on the laws of quantum mechanics, providing a far superior processing capacity than conventional computers. For example, quantum computing may help to accelerate pharmaceutical discovery and development, and improve the accuracy of models used to track climate change and its effects.

Research, learning and economies of scale have reduced the cost of technology

Technology advances are often prompted by cost savings, rather than community preferences and expectations. For example, ATMs and internet banking were motivated by banks' desires to reduce transaction costs, the first genetically modified crops were designed to reduce the need for herbicides, and packaging innovations were designed to reduce spoilage, transport and material costs. Subsequent productivity improvements can reduce prices, enable growth in wages and living standards, or add to profits. Cost-saving technology contributes to productivity growth and international competitiveness.

The rapid growth and declining cost of computing power is a key enabler for more complex analysis, data management and global communication and, more recently, some early forms of artificial intelligence. For example, the average price of a transistor, a key piece of pioneering computing hardware, has declined dramatically since the 1960s. And yet, the capability of the technology – now incorporated into integrated circuits – has grown exponentially, contributing to overall computing cost reductions and allowing a range of people to access the benefits.²¹⁷ Figure 27 shows how the cost of genome sequencing followed this trend between 2002 and 2013 as a result of technological advancement.

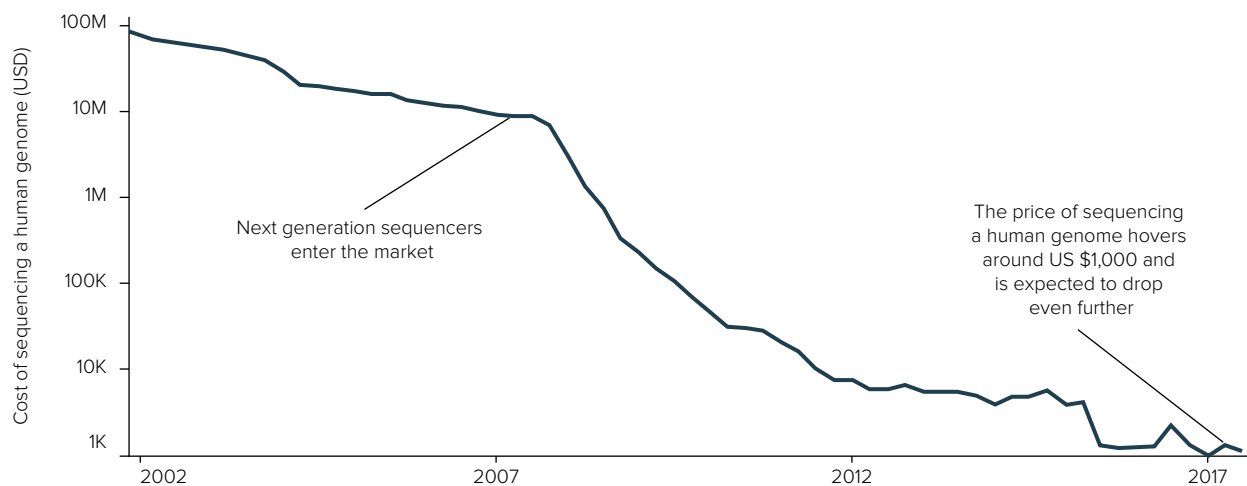
In addition to computer processors, other technologies have also become much cheaper and more powerful over time, including consumer products like household appliances and telecommunications equipment.²¹⁸ While current solar energy technology and battery cost reductions are not as steep as for integrated circuits, they indicate continuing cost reductions with volume over time, alongside improved efficiency and energy density of batteries.²¹⁹

Australia struggles to leverage its technological expertise

Australia's investment in research and development has recently declined, and investment as a proportion of GDP is lower than other OECD nations.²²⁰ Based on researchers per million inhabitants, Australia ranked 10th in 2010.²²¹

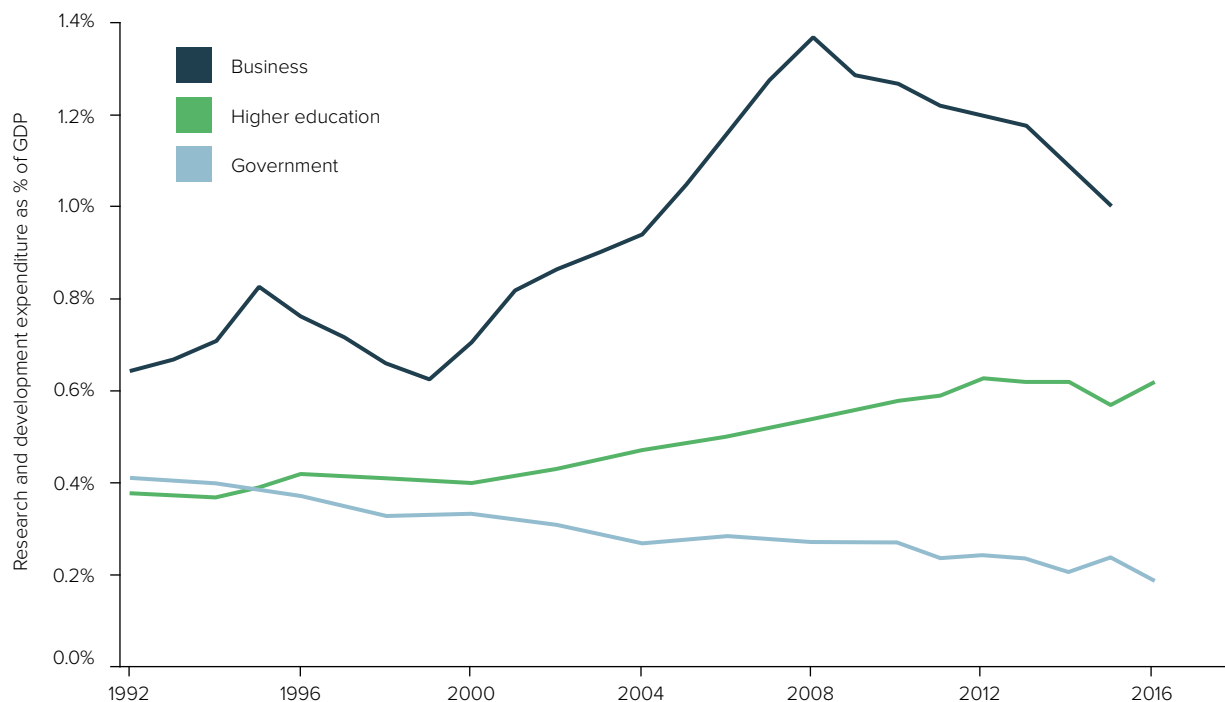
As Figure 28 shows, business spending on research and development (R&D) as a share of GDP peaked in 2008-09 and has fallen steadily to 73% of the pre-GFC height.²²² Direct government spending on R&D halved between 1992 and 2016, while higher education spending is growing modestly, yet not at a rate to offset the other declines. This will have particular implications for regional research centres and universities that rely on government funding and support. In our fast-growing cities, large universities are turning to international students to boost revenue streams.

Figure 27: The cost of sequencing a human genome fell by almost 100 million USD over 15 years



Source: National Human Genome Research Institute (2017)²²³

Figure 28: Business expenditure on research and development decreased recently, while government expenditure has decreased consistently over time



Source: Organisation for Economic Co-operation and Development (2019)²²⁴

While Australians are early technology adopters, Australia does not have a strong record in commercialising its own R&D. For example, researchers at the CSIRO played a significant role in developing Wi-Fi technology, with limited commercial recognition.²²⁵

In particular, manufacturing is a challenge as we lack a large domestic or export market for advanced goods. As they grow, many Australian manufacturing businesses move production offshore, to Asia for low-cost high-quantity goods, or to Europe and North America for high-value medical or information technology products.²²⁶

New technology can require new forms of regulation and control

New technologies often push boundaries before controlling legislation is developed or even the need for legislation is recognised. This has always been the case. For example, standardised signage, traffic lights and seat belts were introduced after cars became commonplace on our roads.

As technology advances, some new technologies may require regulation, policy or infrastructure support to gain maximum benefit. For instance, Australian governments have been slow to establish planning controls or network standards to support widespread public charging networks for electric vehicles.

While new market risks or failures must be managed, clear standards can enable greater interoperability between manufacturers (power points for electricity)

and ease of use by consumers (standardised signs and labelling). New technologies can raise emerging moral and ethical issues. For example, advances in 3D printing create challenges for intellectual property, synthetic biology is testing biosecurity, and neuroscience technology is raising questions about human dignity.²²⁷

As the internet increasingly facilitates our way of life and standard of living, regulators will need to consider how best to make sure the products, services and utilities Australians depend upon remain both accessible and secure. For example, comparable jurisdictions are considering regulating the IoT industry so that domestic item, such as baby monitors, smart TVs, fitness trackers and even autonomous vehicles, have adequate privacy protections in place.

Providing equitable and affordable access to technology will be challenging

While the cost of technology typically decreases over time, the cost and skills required to adopt technology can remain a barrier for some communities and individuals. Socio-economic inequities make it difficult for some residents to fully benefit from connectivity, if they cannot afford a device or ongoing services. Improving technological literacy and skills will be essential within Australia's education and social services sectors.

Policy, regulation and investment in infrastructure will influence access to technology and the development of skills. This is essential as advancements in automation and artificial intelligence cause

occupational obsolescence. Research indicates people show limited concern that technology will replace them in the workplace, and instead embrace new technologies that improve their work.²²⁸ Conversely, automation and artificial intelligence will likely displace an increasing number of workers over coming decades.²²⁹

Delivering new technology and telecommunications connectivity, such as 5G, is generally more cost efficient for governments and businesses in cities, where there is greater demand and density than rural and remote areas. It is also more cost effective to establish transport infrastructure such as roads, rail and public charging stations or other networked technology infrastructure in cities. This may disadvantage rural and regional businesses that do not have reliable internet access to support online sales, purchases or payments.

While costs to establish new technologies in remote and regional areas can be higher than for urban areas, the potential benefits can be greater. Internet connections allow regional producers to participate in metropolitan and even global markets, removing intermediaries. Remote diagnostics and telehealth services can save long trips for patients, and assist existing services such as the Royal Flying Doctor Service.

The opportunity of connectivity must be balanced with privacy and security needs

Digital connectivity is producing more data than ever before. This can optimise experiences, improve efficiencies and lead the way for new technologies. For example, enhancements such as digital twins (a virtual replica of a physical asset) can improve maintenance practices and cut costs. At the same time, increasing personalisation of services and products means providers know more about individuals, and may use that knowledge to their advantage and profit.

This proliferation of data presents challenges in managing its use, ownership, and the privacy and security of the information, and how it is used. Ensuring trust in technology will require greater transparency from governments and businesses in how data is used and how decisions around technology are made. It will also need to recognise that consumers, as the source of most data that creates new services, will increasingly expect to retain control over its use. For example:

- Voice-activated digital assistants and smart TVs monitor and analyse the sounds in their environment to know when they are required and to interpret requests. Consumers may not know what these devices hear and who can access this data.
- Businesses may keep records of locational transactions, searches, personal information or communications for confirmation or legal reasons. This raises questions about data security and use.

- The transparency of commercial arrangements is declining, with people agreeing to terms and conditions without taking the time to read or understand them. Personalised terms and conditions are rare.
- Retailers use purchasing patterns to predict personal information about a wide array of features of people's lives from travel plans, pregnancy or moving to a new house and then target information about related products and services. While some people find this useful, others have concerns about intrusion and selling on of information.

Globally, the European Union's General Data Protection Regulation has set standards for limits on the gathering and re-use of data, particularly strengthening consent conditions for the use of data and penalties for breaches.²³⁰ There is also uncertainty about the ability of national governments and institutions to manage communication technologies and service providers that have become globally dominant. We see this in efforts to control what content (for example, violent videos) social media companies can share.

Platforms (such as Google or Amazon) offer consumers benefits at minimal or no cost, while potentially restricting or damaging businesses that seek to use them if this challenges the platform's own data control. This is challenging for competition regulators, as competition law usually judges anti-competitive behaviour based around its ultimate impact on the consumer.

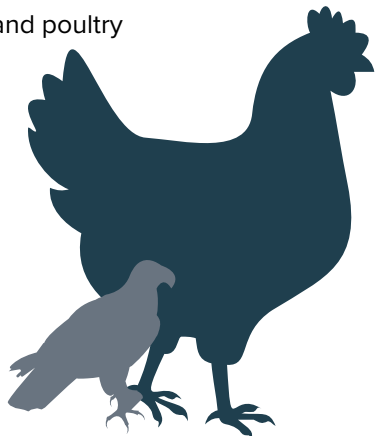
Big data resources and improvements in algorithm technology and fuzzy logic are allowing service providers to analyse larger amounts of data that provides opportunities for research and innovation, gaining new insights into how large-scale systems work as well as responding to individual preferences and expectations. Some algorithms and forms of AI can be inscrutable and may have built-in but unknown biases. The decisions and insights can be difficult to challenge even when decisions lead to poor outcomes, such as denial of or delayed access to services, payment of premiums or penalties, or passing information to others at the detriment of safety or privacy.

Securing digital and telecommunication networks, such as payment systems, against cyberattacks and misuse of confidential data sets will be paramount as the impacts and costs of such disruptions increase. The Australian Government is investing in cyber research and developing knowledge centres that provide information exchange and technical support to industry. However, as cyber threats become more complex and pervasive, the policies that govern the use and defence of computer systems will have to be reviewed and updated.

Environment and resilience – snapshot

Birds in the world

70% chicken and poultry
30% wild



Land mass

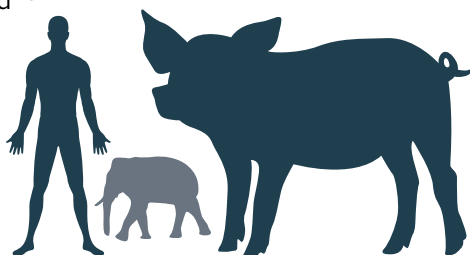


Population



Mammals in the world

60% livestock
36% humans
4% wild ²³¹



90% of Australians

live on 0.22% of the country's land area ²³²

Average temperature across Australia projected to rise by
0.6-1.5°C by 2030 ²³³



Average rainfall in southeast Australia

declined by 11%
since 1990s ²³⁴

Australians produce

9% more waste per person

than comparable nations ²³⁶



2.8 Environment and resilience

At a glance

Australia's environment is an invaluable source of pleasure to many Australians and a major asset for nation's economy. Climatic and weather extremes, alongside the sheer size of the continent, present both opportunities and threats. These manifest differently across the nation and economy, and are increasing in importance as the impacts of a changing climate are realised.

The agriculture, tourism, mining, manufacturing and service industries are all experiencing the impact of a changing climate and its consequences for our environment and economy. Our coastal, regional and remote communities, outer-urban growth areas and inner cities are impacting on and being impacted by our environment and climate, albeit in different ways.

This section looks at how climate change will affect us in the coming years. Australia is a high per-capita greenhouse gas emitter, and we are not on track to meet our emission reduction targets. In the light of the science, it is clear that the resilience of both our communities and economic sectors will be challenged by climate change, and further investments in climate change adaptation and a restructuring of economic activity are essential.

Our society and economy have been shaped by our environment

Australia's environment is one of extremes. It is a land of flood, drought, fire and cyclone – the driest continent on earth, with much of our land mass unable to support intensive settlement. Despite this, Australia's environment is the foundation of our social and economic wellbeing – we produce, consume and export high-quality fresh food from the ground, we extract, consume and export valuable minerals from underneath it, we enjoy clean air, water and diverse landscapes, and people travel across the world to experience our unique flora and fauna.

Our environment has long shaped, and been shaped by, people. Over 65,000 years of Aboriginal and Torres Strait Islander land management used the elements, such as fire, to protect, renew, and enhance the resilience of Australia's environment. Today, our environment faces increasing pressure from human activity and the effects of climate change, affecting not only liveability and quality of life, but also our economic opportunities.

Our unique environment faces threats from human activities

There is often a tension between the economic uses for land, such as to build our cities and towns, accommodate a growing population, support the movement of people and goods through infrastructure, provide for agriculture, support resources extraction, or reserve land for conservation and potentially tourism. Consequently, properly identifying and valuing environmental assets, or the direct and indirect economic value that can be derived from intact ecosystems, is difficult and often underestimated. Balancing the land-use needs of human economic development without exceeding the tolerance of environmental resilience is a challenge.

For example, a report on the Great Barrier Reef, a UNESCO World Heritage listed site of unique beauty and biodiversity, estimated an 'economic, social and icon asset value of \$56 billion [supporting] 64,000 jobs and [contributing] \$6.4 billion to the Australian economy'.²³⁷ However, this valuation acknowledged that it did not include ecosystem services such as water purification, or the reef's role in protecting coastal areas from the most extreme effects of storms. Doing so would add significantly to this estimated value.

Protecting Australia's environment will be a challenge as the population grows and habitats are increasingly threatened by other uses. Globally, the human share of land use has expanded as populations have grown and our cities and towns have expanded, eroding our ecosystems and natural assets. Today, nearly half of the earth's land surface is used for human food production, with more used for forestry and settlements.²³⁸

In many areas, the use of the planet's resources is approaching the boundaries of its capacity to support us. Global climate change is widely accepted by the scientific and business community, who acknowledge the significant threats we face if warming continues at predicted rates.²³⁹ However, it is only one of many environmental issues that need to be considered in planning for Australia's environmental future. We are particularly vulnerable to freshwater access and use ocean acidification, the impacts of exotic species introduction, habitat fragmentation and deforestation, land degradation and high intensity resource consumption.²⁴⁰

How we use land will need to adapt to changing environmental conditions, particularly in regional and remote areas where agricultural production requires specific conditions in terms of soil profile, salinity, rainfall and heat.

Some agricultural regions will no longer be suitable for production. Crops may need to move to new locations, and some areas will become less viable or even unviable for production. The threat of low stream flows on aquatic life and pollution of waterways and oceans will become an increasing risk, as will erosion of coastal areas if these issues are not managed effectively. While protecting marine park biodiversity is essential, protections must not excessively affect other sectors, such as the food industry and freight transport. In fast-growing cities, urban sprawl has encroached on natural habitats and agricultural land. There are already increasing numbers of threatened species on the edges of Australia's large cities.²⁴¹ In particular, road and rail corridors can fragment animal habitats.

Environmental challenges and responses vary across Australia

Australia is one of the world's most urbanised countries. While 90% of Australians live on only 0.22% of the continent's land area, vegetation clearing and land use have had significant impacts on Australia's biodiversity, including habitat fragmentation and species loss, erosion and land degradation, and pollution.²⁴² Individual environmental pressures can accumulate over time, amplifying threats to the environment and requiring integrated approaches to manage.

Vegetation clearing in Australia is concentrated in the long-settled agricultural and coastal zones, where more than 50% of native vegetation has been cleared. Land has typically been cleared to create spaces for productive use, for people and economic development.²⁴³ From 2011 to 2016, land-clearing rates stabilised in all states and territories, except Queensland, where clearing increased after changes to the *Vegetation Management Act 1999* (Qld) in 2013.²⁴⁴ This has resulted in half the species listed as threatened under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) being considered as at risk from habitat fragmentation, including 11 mammal species unique to Australia.²⁴⁵ There is pressure on a further 34 threatened and near-threatened species.²⁴⁶

Increased mining activity over recent decades has created extensive and lasting impacts on Australia's environment. In New South Wales and Queensland, the recent expansion of coal mining and the coal seam gas industry has also led to conflict with other uses on prime agricultural land. Additional state and national oversight now manages access to water resources, in order to limit potential contamination. In Western Australia, particularly the Pilbara region, immense economic opportunities provided by mining activities have significant impacts on local landscapes and biodiversity.

Australia is one of the world's largest waste generators, producing 9% more than comparable countries per person.²⁴⁷ We have achieved limited progress on waste reduction or on recycling more waste material back into useful products. Our coastal waterways are increasingly threatened by pollution from plastic debris, microplastics and nanoparticles entering coastal waters through sewage contaminated by fibres from washing of clothes or from cleaning products. These are largely unregulated, and their effects are poorly understood.

The sheer size of Australia means that climatic conditions already vary greatly across the continent – from a tropical monsoon climate in the far north, through to desert and semi-arid conditions across most of the interior, to more temperate conditions along the east coast.

We also experience short- to medium-term climate and weather cycles influenced by changes in the nearby Pacific and Indian Oceans. Rainfall patterns and sea temperatures across Australia fluctuate according to oscillations, generally lasting between three and five years – the El Niño Southern Oscillation (ENSO) in the Pacific Ocean and the Indian Ocean Dipole (IOD). These dynamics provide a medium-term outlook for Australia's climatic patterns.

The ENSO can produce either El Niño or La Niña events. El Niño events generally deliver warmer and drier conditions to southern and eastern Australia, and can contribute to increased numbers of bushfires and heatwaves. La Niña events deliver higher than average rainfall and a higher incidence of tropical cyclones. The Bureau of Meteorology outlook in early 2019 is at El Niño alert due to warmer than average ocean temperatures since mid-2018, although other conditions are currently not reinforcing this. Strong negative Indian Ocean Dipole events deliver higher than average rainfall to Australia's west.²⁴⁸

Air quality is also a key determinant of liveability. Australia's growing population and density, car use, coupled with natural weather events such as fires, dust storms and pollen can increase the amount of particulate matter in the air, reducing air quality.²⁴⁹ At current levels, air quality in Australian cities is classified as either 'good' or 'very good'.²⁵⁰ Levels of particulate pollution such as carbon monoxide, lead, nitrogen dioxide, coarse particulate matter and sulphur dioxide have decreased over the past 15 years. However, levels of ozone and fine particles remained stable.²⁵¹



Climate variations will be exacerbated by climate change

Increasing impacts from longer-term global climate change are likely to intensify ongoing weather and climate patterns. The International Panel on Climate Change estimates that global warming is likely to reach 1.5°C above pre-industrial levels between 2030 and 2052 if current rates continue, impacting land, sea and air environmental systems across the world.²⁵²

In Australia, air and sea temperatures have increased by 1°C on average across the country since 1910, with most of that warming since 1950.²⁵³ We experienced our hottest summer on record in 2018-19.²⁵⁴ Further increases in air and sea temperatures are predicted over the coming decades. This will lead to more hot days, increasing ocean acidification and sea level rises, affecting coastal erosion and inundation. Average temperatures across Australia are projected to rise by a further 0.6 to 1.5°C by 2030.²⁵⁵

We can expect the impacts of climate change to further affect Australia in a number of ways. Changes in regional daily and seasonal weather patterns as a result of climate change, will affect the essential functioning and liveability of our communities. Likely impacts include:

- An increasing risk of interruptions to critical infrastructure and services as a result of more extreme weather events (for example, pressure on public transport and health services due to increased frequency of heatwaves).
- Increased instance of compound events, for example extreme storm surges combined with extreme rainfall leading to extreme coastal flooding.²⁵⁶

- Tropical cyclones extending further into southern Queensland and northern New South Wales.²⁵⁷
- The migration of pests into regions previously pest free, for example the fruit fly into southern states.²⁵⁸
- Coastal flooding during peak tides, affecting land as much as 10 km inland in some parts of coastal Queensland.²⁵⁹
- A rise in the 'urban heat island effect' (increased temperatures in built up urban areas, compared to surrounding areas) in our cities, particularly those with increasing development densities.
- Declining snowfall in ski regions in Victoria and New South Wales and reduced days with conditions suitable for artificially made snow.²⁶⁰
- Insufficient chill hours for certain stone-fruit crops to remain viable in some areas.²⁶¹
- Structural industry changes including the shift of agricultural activities to new regions, for example winemaking is already growing in Tasmania.

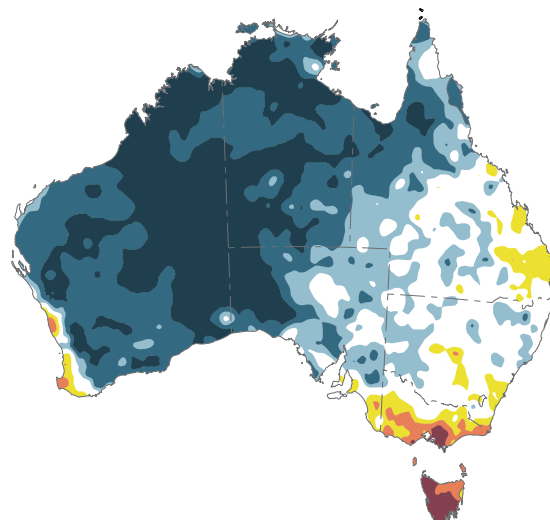
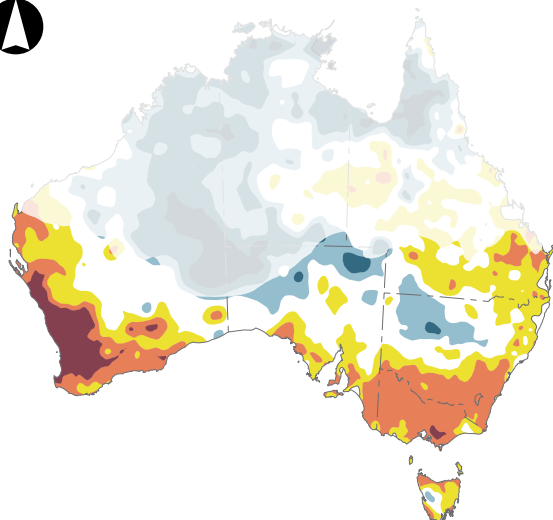
As a dry continent, rain is essential to maintaining liveability and productivity in Australia. Average rainfall in the south east of the country has declined 11% since the late 1990s, while it has increased across northern Australia, particularly during the wet season (October to April) (Figure 29).²⁶² Perth has also suffered major reductions in rainfall since the 1990s.

Further changes in rainfall patterns are expected to exacerbate drought conditions across southern Australia, where larger proportions of the population live, and where much of our agricultural production occurs. Changes are also expected to create flooding issues from intense heavy rain across northern Australia.²⁶³ Bushfire seasons are also growing in length and intensity in nearly all bushfire-prone areas of the continent, particularly in the south and east (Figure 30).²⁶⁴

Figure 29: Winter rainfall is declining across southern Australia, while summer (wet season) rainfall is increasing across the north and west of the country

April to October

October to April



Rainfall decile ranges

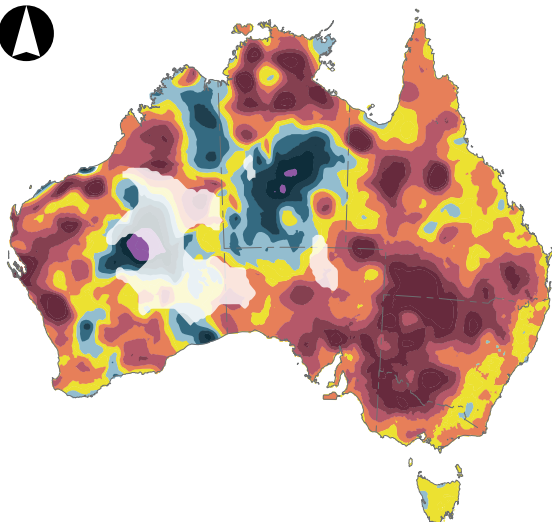
10 Highest on record 8-9 Very much above average Above average 4-7 Average 2-3 Below average 1 Very much below average Lowest on record

Note: Areas across northern and central Australia that receive less than 40% of their annual rainfall during April to October have been faded.

Source: Commonwealth Scientific and Industrial Research Organisation and Bureau of Meteorology (2018)²⁶⁵

Figure 30: Bushfire danger has increased in the south and east of Australia

Change in forest fire danger index to 2018



Forest fire danger index points/decade

400 300 200 100 0 -100 -200 -300 -400

Source: Commonwealth Scientific and Industrial Research Organisation and Bureau of Meteorology (2018)²⁶⁶

Over time, these impacts may be compounded. For example, the combination of reduced rainfall and higher temperatures leads to greater evaporation. This can reduce both groundwater recharge and stream flows, as is already evident in southwest Western Australia and is likely to prevail across many other parts of the country. Drier conditions will contribute to more frequent and severe dust storms and bushfires. More intense tropical cyclones with lower atmospheric pressure can combine with sea level rise to add higher than historical storm surges that then meet run-off from heavier rainfall. It is expected this will cause more severe coastal inundation and erosion than any one of these three effects in isolation. These three events are more likely to coincide with climate change.²⁶⁷

As the climate changes, ecosystems will also change. Some species will move, others will be unable to move or adapt and will succumb to extinction. Fragmentation, species loss and stress from pollution and disturbance will make adaptation more difficult.²⁶⁸ Climate change is also likely to affect the viability, distribution and occurrence of invasive species, creating challenges for managing their impact in new regions.

Australia is a high per capita emitter of greenhouse gas emissions

Increased levels of greenhouse gas emissions (particularly carbon dioxide, but also including methane, nitrous oxide, ozone, chlorofluorocarbons and hydrofluorocarbons) in the atmosphere is the primary cause of global warming and climate change.²⁶⁹

In 2018, Australia emitted an average of 21 tonnes of CO₂ equivalent per capita, compared to a global average of around 7 tonnes of CO₂ equivalent per capita in 2017 (including land-use change).²⁷⁰ This puts Australia in the top 10 emitters in the OECD.²⁷¹

This is due to a number of reasons, including:

- The types of industries that support our economy, such as mining
- The emissions intensity of our primary energy and fuel sources, such as coal
- Our large passenger and freight tasks due to the size of the country, undertaken by road, rail, air and sea
- The extremes of the Australian environment, such as severe heat, which encourages increased use of air conditioning.

The Australian Government has committed to reduce its greenhouse gas emissions through international agreements in response to global climate change. Australia is expected to meet its 2020 Kyoto Protocol target of a 5% reduction from 2000 levels.²⁷² The Government committed to further reduce emissions as part of the Paris Agreement in 2015 – to 26-28% below 2005 levels by 2030.²⁷³

In December 2018, the Australian Government Department of Environment and Energy projected that Australia's emissions would grow to 2030 (Figure 31). The increase was largely attributable to increases from transport, direct combustion, fugitive emissions and agriculture.

In February 2019, the Australian Government announced the Climate Solutions Package (the Package) and consequently it is not considered in the 2018 projections. The Package aims to deliver an additional 200 million tonnes of emissions reductions by 2030, through the \$2 billion Climate Solutions Fund, energy efficiency measures, a second electricity interconnector to Tasmania supported by new pumped hydro projects (the Battery of the Nation) and a national strategy for electric vehicles.²⁷⁴

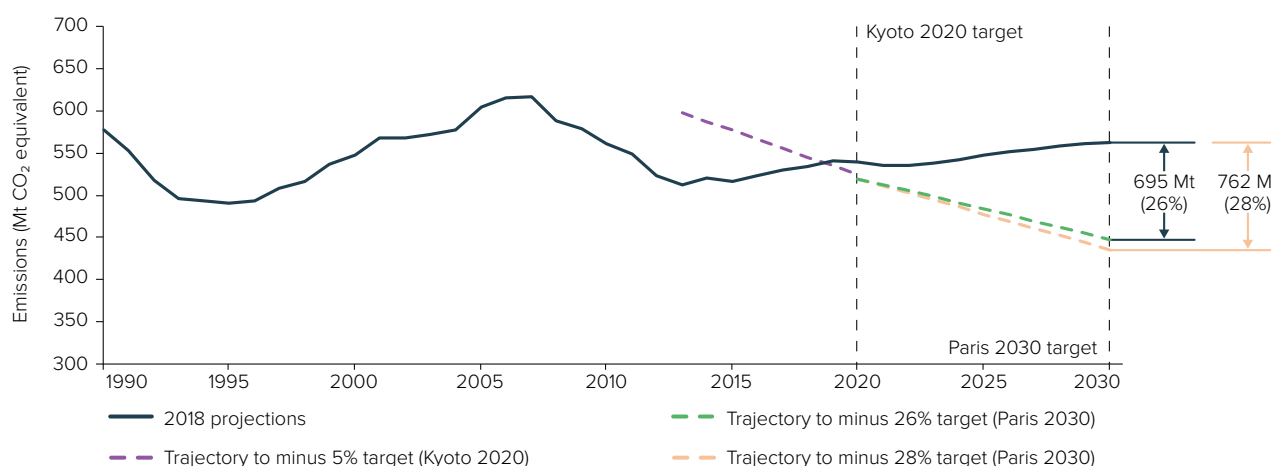
The Department of the Environment and Energy forecast in the Package that these measures, plus other technology improvements and abatement sources, energy performance improvements, Snowy 2.0, and Australia's level of reductions against its Kyoto Protocol targets, will position Australia to meet its Paris Agreement 2030 targets.

The effectiveness and timing of these measures, and the anticipated technology and energy efficiency improvements, will need to be monitored to ensure their impacts are in line with expectations. The Department's annual emissions projections report tracks progress towards emissions targets, and the 2019 report will be the first to incorporate the Climate Solutions Package. This report, and future reports, will track the effectiveness of the Climate Solutions Package over time.

Importantly, the infrastructure sector will play a critical role in delivering these mitigation measures including through ensuring projects are delivered on time, such as Snowy 2.0 and the Battery of the Nation, as well as enabling the transition to electric vehicles.

While total emissions have reduced since 2005, including significant declines in the energy sector (due to expansion in renewable energy markets and reductions in electricity demand), transport, direct combustion and fugitive emissions continue to grow.²⁷⁵

Figure 31: Prior to Climate Solutions Package, Australia's emissions were projected to rise



As Figure 32 shows, Australian emissions per capita have fallen by around one-third since 1990 but have levelled off in recent years.

Emissions intensity per dollar of GDP also continues to decline slowly. These trends include land use, land-use change, and forestry (LULUCF), which accounted for most of the decline in per capita (and total) emissions. The fall in LULUCF has been the largest of any sector (it now contributes positively to Australia's emissions abatement) due to increasing restrictions on land clearing and changed forestry management.²⁷⁷

Environmental adaptation and resilience provide broad community benefits

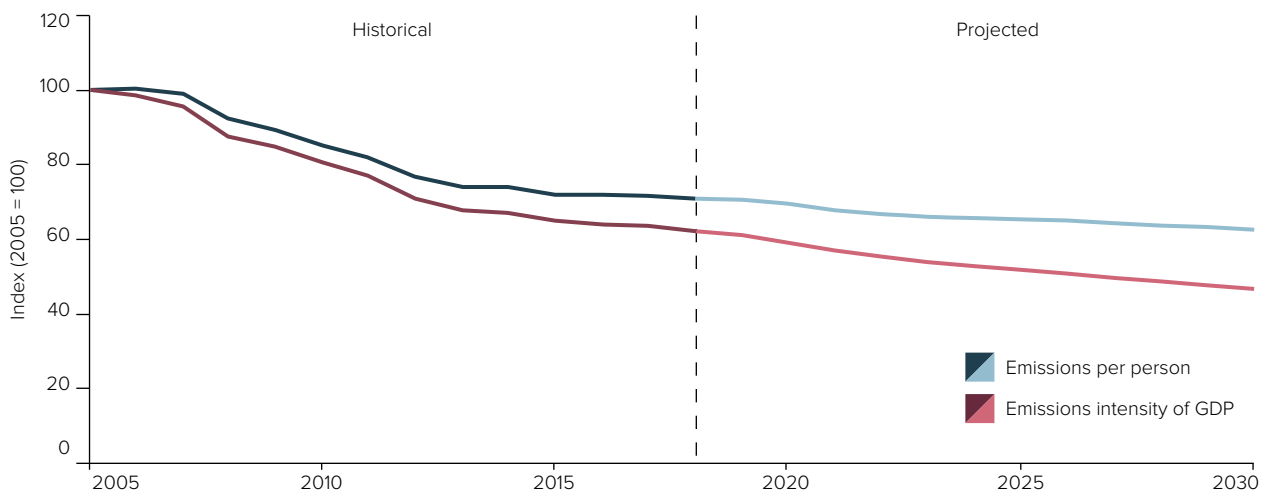
Responding to short- and long-term shifts in our environment is driving adaptation in the way we interact with our infrastructure and built environment, and the land, ocean, air and biodiversity. Adaptation to a changing environment is an ongoing process for a country as large and diverse as Australia.

Some adaptations are driven by changing behaviours, such as reductions in energy and water use per person, so even as our population grows, demand is not growing at the same rate. For example, energy consumption in the residential sector grew

by an average 0.7% p.a. over the 10 years to 2016-17, lower than half the rate of population growth over the same period.²⁷⁸ Changes in technology are driving others, such as increased use of solar and wind energy due to cheaper, more efficient technology. Australia's agricultural land management is also changing, with reductions in chemical use in the cotton industry, largely from the adoption of genetically modified cotton,²⁷⁹ more careful use of fertilisers in sensitive environments such as catchments of the Great Barrier Reef, and approaches to grazing management that reduce erosion while increasing productivity. There is also a growing recognition that land management practices adopted by Aboriginal and Torres Strait Islander people, prior to colonisation, provide useful insights into resilient and sustainable land management and adaptation over coming decades as environmental conditions change.

Adaptation is providing benefits beyond the environment too, particularly for community health, economic productivity and more efficient operations in industry. Many of these benefits are most keenly felt in our fast-growing cities where the economic opportunities from increased efficiency, productivity improvements and sustainable supply chains are more immediately realised.

Figure 32: Australian emissions per capita and as a percentage of GDP are falling



Source: Australian Government Department of the Environment and Energy (2018)²⁸⁰



Building resilience through our cities and infrastructure

As a highly urbanised nation, our cities and towns have a significant impact on our environment and our ability to build resilience and respond to climate change. Across Australia, the built environment represents a major energy consumer, and the operation of our buildings alone contributes 23% of our national greenhouse gas emissions.²⁸¹ In 2013, energy use from residential buildings was responsible for slightly more than half (51%) of total emissions in the buildings sector, commercial buildings contributed the remainder. However, total emissions from buildings are expected to remain relatively stable over the period to 2050, with increased emissions from energy consumption offset by substantial ongoing uptake of distributed solar photovoltaics installation.²⁸²

Improvements in other aspects of the built environment present considerable opportunities to further reduce the emissions profile of our buildings, communities and cities, ease the transition to a low-carbon future across the economy, and build resilience. These include improving the efficiency of appliances, equipment and building envelopes, fuel switching to electric alternatives, and deployment of on-site distributed energy and water systems or off-site low-carbon electricity.

Initiatives across our cities are supporting this transition. For example, the urban heat island effect is increasing across many Australian cities. Rising air temperatures, poor urban design and a decrease in vegetation are contributing to increased temperatures in our cities, often at the ground level, affecting liveability and the comfort of the urban environment. Some cities are beginning to

implement new adaptive responses that will cool urban environments and protect biodiversity, while providing more pleasant, greener environments with more actively used shared open spaces. These responses can also support broader ecosystem services that provide flood mitigation, water quality control and nutrient cycling.²⁸³ A range of broader economic, social and community benefits are increasingly identified as being associated with these investments, for example through value uplifts, improved health and wellbeing, and social inclusion.

Recognising these risks, and the opportunities, our cities are beginning to strategically plan for resilience, particularly in the face of uncertain environmental conditions. For example, both Sydney and Melbourne are members of the 100 Resilient Cities program aiming to build the capacity for cities around the world to plan for and adapt to a changing world whilst also maintaining and enhancing city liveability, social cohesion and economic productivity.²⁸⁴

Alongside this, industry is meeting a global demand for investment in low-carbon, resilient, sustainable infrastructure and real estate assets. Sustainable investing has been measured at US\$30.7 trillion at the start of 2018, up 34% in two years across five major global markets of the United States, Europe, Canada, Japan, Australia and New Zealand.²⁸⁵ Increasing commitments by investors and fund managers to portfolios of assets that will have 'net zero' carbon emissions consistent with global targets, are driving transparency in reporting and disclosure that is transforming markets and supply chains to improve sustainability, resilience and reduce carbon emissions across property and infrastructure.²⁸⁶

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