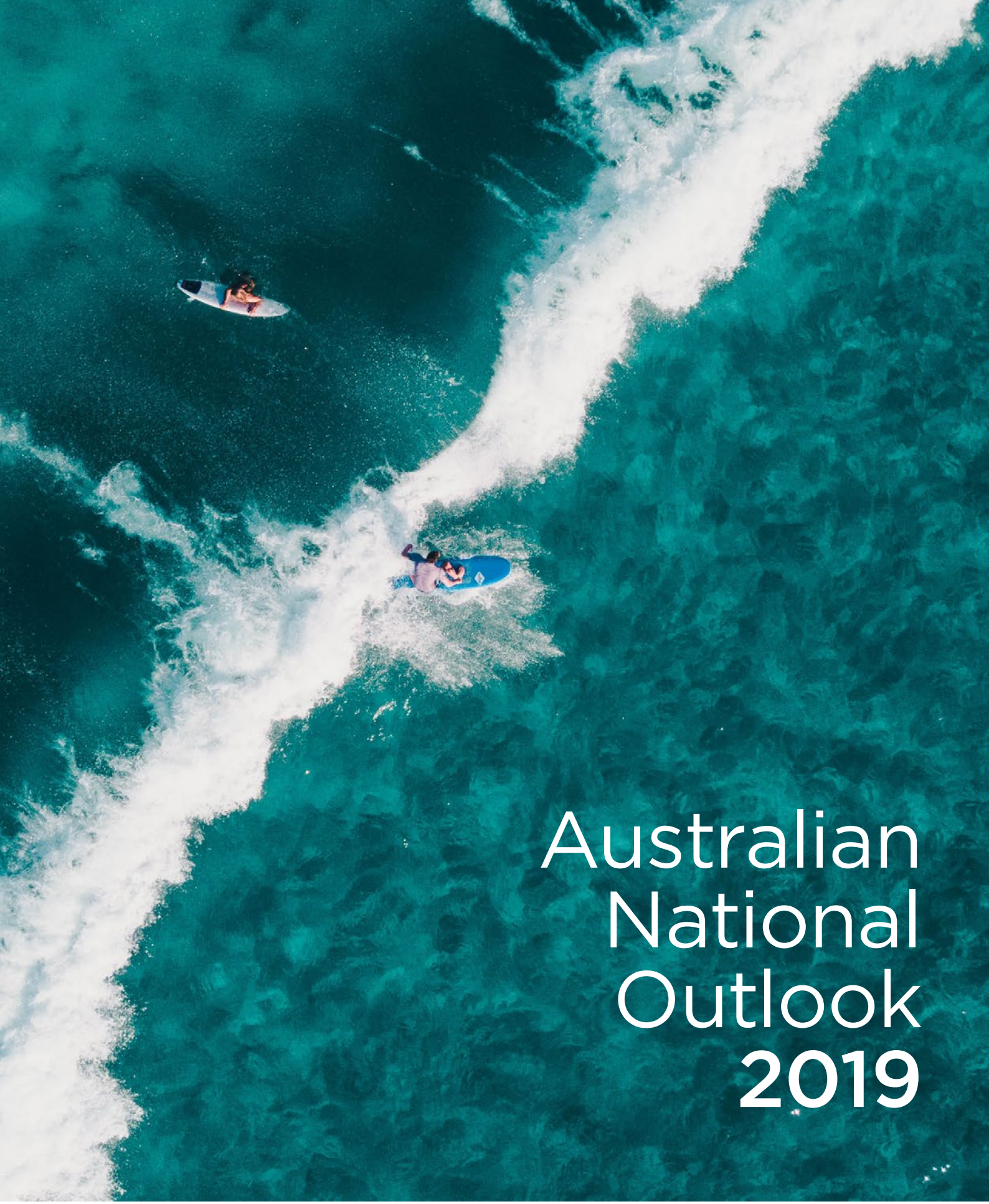

Australian National Outlook 2019

CSIRO

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CSIRO and the National Outlook participants acknowledge the Traditional Owners of the lands that we live and work on across Australia and pay their respect to Elders past and present. CSIRO and the participants recognise that Aboriginal and Torres Strait Islander peoples have made and will continue to make extraordinary contributions to all aspects of Australian life including culture, economy and science.

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Joint Chairmen's Foreword

Solving Australia's greatest challenges with the help of science and technology has never been more important – for our quality of life, for the economic health of our nation, and for our contribution and position in a globally competitive world.

Today, Australia's economy has strong jobs growth and business conditions indicative of sustained business investment. We've had nearly three decades of economic growth, and our quality of life is arguably the envy of the world.

But there are challenges

Some concerning trends are emerging that mean we need to think differently if we are going to ensure, and plan, towards a bright and prosperous future.

Wage growth has slowed, and house prices have surged in real terms over the past two decades. Our growing but ageing population is placing greater stress on our cities and infrastructure. On important international measures the performance of our schools is falling.

New and seemingly disruptive technologies, such as artificial intelligence, are posing new challenges as we grapple with how to harness them, and at the same time protect our information and our way of life. And we are being challenged to ensure we develop great new jobs and people with the right skills in Australia to perform them.

Our environment is under significant pressure. Australia has always had to face a harsh environment and adapt to its conditions, but rising sea temperatures, drought, floods and an uncertain energy path ahead are testing even our greatest resolve. Global warming is not in any doubt. Without significant action to reduce greenhouse gas emissions, we could be on a path to 4°C global warming (or worse) by 2100.

Our place in the region and the region's impact on us needs consideration, as Asia's population continues to grow, and many Asian economies are becoming more competitive.

A collaborative approach

If we can understand future challenges and opportunities, plan and act – our children, grandchildren, and great grandchildren will be able to enjoy a great quality of life. This cannot be the responsibility of government alone. Business, the education and community sectors, other non-government organisations and individuals all play a role.

It's this understanding that helped to bring together more than 50 leaders from 22 organisations across sectors, to work with CSIRO as part of the second Australian National Outlook project (ANO 2019).

ANO 2019 builds on the work of the first Australian National Outlook report published by CSIRO in 2015. Led by CSIRO and NAB, ANO 2019 is the culmination of two years of sophisticated integrated modelling by CSIRO and the expertise of many of Australia's business, academic and non-profit leaders, to examine what kind of country Australia could be in 2060.

Australia's opportunity

Some of the findings of the ANO 2019 report are confronting. The report shows Australia is at risk of falling into a slow decline if no action is taken on its most significant economic, social and environmental challenges. However, the report also outlines the bright future we can achieve as a nation, if Australia tackles these challenges head on. We have the opportunity – right now – to help build a future where Australia has prosperous and globally competitive industries, inclusive and enabling communities, sustainable natural resources and strong public and civic institutions.

This report does not attempt to cover every challenge Australia is facing, nor do we have all the solutions. But we hope it will help kick-start a national conversation about where Australia is heading and what we can all do about it. Together we can consider the levers within our reach to drive change, as individuals and collaboratively, to have a meaningful impact on the future for all Australians, and take meaningful action.

Put simply, we can no longer afford to ignore what we know is coming.

On behalf of all the participants in the Australian National Outlook 2019, it is our pleasure to present this report to you.

Dr Ken Henry AC
Chairman, National Australia Bank
Joint Chair, Australian National Outlook 2019

David Thodey AO
Chairman, CSIRO
Joint Chair, Australian National Outlook 2019

Chief Executive Foreword

For over 100 years, the CSIRO has been solving Australia's greatest challenges through science and technology. Whether it's been addressing the rabbit plague with myxomatosis, creating new drought-resistant cotton to give Australia an unfair advantage, or transforming the world with breakthrough innovations like ultrasound imaging and Wi-Fi.

They are impacts which affected not only the 'here and now' of the immediate challenge, but for future generations. Through science and technology we've created healthier Australians, a more sustainable environment, entire new industries and new jobs, and grown the wealth of the nation.

But what of the future?

With an increasingly global world, the rapid disruption of even the most stalwart and steady industries, and the impacts of social, environmental and technological change, the challenges are all the more significant.

The Australian National Outlook research

Every few years, we take a special look at Australia's future through a new research lens which we launched in 2015, called the CSIRO Australian National Outlook, or ANO.

The ANO brings CSIRO's research methodology in forecasting, combined with social, environmental and economic data and perspectives, to predict where Australia might be in decades to come.

The Australian National Outlook 2015 report looked out to 2050, and sought to provide a better understanding of Australia's physical economy. It had a particular focus on understanding two aspects: the 'water-energy-food nexus' and the prospects for Australia's materials and energy-intensive industries.

Four years on, we look further ahead, to 2060, with the Australian National Outlook 2019.

Australia is at a crossroads

The latest ANO research tells us Australia is at a crossroads – stride towards a more positive future outlook filled with growth, or face a slow decline.

The research argues that it is possible to achieve higher GDP per capita (as much as 36%), while ensuring growth is inclusive and environmentally sustainable. In a global context, strong co-operation on climate change and trade can deliver a better outcome for Australia without significantly impacting our economic growth, where before it may have been thought impossible.

But with a positive outlook comes critical elements that must change – five major shifts: an industry shift; an urban shift; an energy shift; a land shift and a culture shift.

So how can we navigate to the best path?

In many ways, we've been here before and science has provided an answer – by focusing on solving the greatest challenges. Great strides have already been made against the six challenges we are assisting the nation to overcome, and turn to Australia's advantage:

1. Food security and quality
2. Health and wellbeing
3. Resilient and valuable environments
4. Sustainable energy and resources
5. Future industries and
6. A secure Australia and region

In the face of climate change and the challenge to create a resilient and valuable environment, we have reduced carbon emissions from livestock, which represents 10% of Australia's total emissions, by creating FutureFeed, a feed supplement that utilises a specific type of seaweed which can increase production and virtually eliminate methane emissions simultaneously.

In the face of a growing world population and the challenge to ensure food security and quality in an environmentally responsible way, TranspiratiONal is an environmentally-friendly, sprayable biodegradable polymer membrane product that can help farmers produce more during harvest on the same land area, while using less water, nutrients and agrochemicals.

To address making the most of limited resources and meet the challenge of sustainable energy and resources, we're using science and technology to accelerate the output from our land. An online crop production model Yield Prophet® provides grain growers and consultants with paddock-specific yield forecasts as well as crop growth and resource information, helping growers to avoid over- or under-investing in their crop.

Combining artificial intelligence, machine learning and cloud-based geospatial technology, we're using technology to address a number of challenges. In agriculture, for example, working with rural technology start-up Digital Agriculture Services (DAS), the Rural Intelligence Platform is the first ever software to comprehensively assess and monitor rural land anywhere in Australia, drawing on information about productivity, water access, yield, land use, crop type, rainfall, drought impact and more. Allowing the producer to better plan for the future.

Working with Amfora, we are developing the technology to produce energy-rich feed for livestock, extracting oil from vegetative tissue, such as in stems and leaves, opening up the possibility of trebling oil productivity and greatly expanding renewable oil production worldwide.

As our biodiversity comes under ever-increasing pressure, we are looking to identify risks to threatened and endangered species and to the sustainable management of fisheries, through fish DNA.

In the face of our energy challenge, and in response to the quest for stronger resource exports, we've developed a metal membrane to extract pure hydrogen from ammonia, paving the way for a new Australian renewable hydrogen export industry.

Creating new value

When Australian science solves a seemingly impossible problem, new value is created for society. We admire great Australian innovators like Cochlear who led the world with their unique, seemingly impossible implant – they saw a challenge, solved it with science, and created a new market, and new jobs for generations. But we need more Cochlears, more WiFis, more soft contact lenses, and we need them here in Australia.

With its unique insights from experts in finance, energy, construction, sciences and community services, the data and scenarios shared in this second Australian National Outlook, I hope will serve as a resurgence and rally cry for what we can achieve together. When the community works together, we can solve our challenges and shape our future

It is a purpose the CSIRO has been committed to for over 100 years and is committed to for evermore. Science and technology in the pursuit of solving Australia's greatest challenges, for a better future for everyone.

Dr Larry Marshall
Chief Executive, CSIRO

1 Introduction

The *Australian National Outlook 2019* report explores a range of nationally significant issues, risks and opportunities to identify how Australia's long-term prosperity can be secured. It seeks to answer the question: how can Australians continue to enjoy the best quality of life available to any nation, and importantly how can we ensure that future generations can access even better opportunities?

It builds on the world-leading scientific achievement of the Australian National Outlook 2015,[1] combining CSIRO's integrated modelling and research with input from the National Outlook participants, a group comprised of over 50 leaders across 22 well-known Australian organisations from industry, the not-for-profit and education sectors.

The Australian National Outlook 2015 sought to provide a better understanding of Australia's physical economy (material and energy-intensive industries). In this second ANO report, the research and technical scope has been broadened to explore the economy, including new technology and science-based industries, cities and infrastructure, energy and emissions, and land use through a highly collaborative approach with National Outlook participants.

1 CSIRO (2015) Australian National Outlook 2015: economic activity, resource use, environmental performance and living standards, 1970–2050. CSIRO

Australia faces an uncertain future

Australia is fortunate in many regards. It has enjoyed nearly three decades of uninterrupted economic growth, fuelled by economic reforms, population growth, a vibrant and prosperous private sector with thriving domestic and global businesses, and strong global demand for raw materials.[2]

Over this period, Australia has been fortunate to experience strong growth in median wealth[3] and relatively strong employment opportunities. Australia's cities have consistently been ranked among the most liveable in the world, with access to world-class public services.[4] Its landscapes and marine ecosystems are rich in both biodiversity and natural resources.[5] Its long history of strong, trusted institutions and liberal democracy has enabled a high level of social cohesion and generally fostered consensus on many of its most difficult national challenges.

But there are sound reasons to question whether this good fortune will continue into the future.

The world is changing, and Australia will need to adapt much more rapidly than in the past if it is to keep up. Nowhere is this more evident than in the role that new technologies, such as artificial intelligence, automation and life sciences, are playing in transforming established industries and creating new ones.

At the same time, Asia's continued rise is shifting both the geopolitical and economic landscape. Environmental impacts and biodiversity loss continue to draw increased scrutiny across the globe, with climate change seen as a significant economic, environmental and social issue for Australia and the world.

Australia also faces a number of domestic challenges. Its dependence on natural resource exports leaves it vulnerable to commodity price shocks as well as technology disruption. Its ability to attract and retain innovative entrepreneurs leaves Australia behind world-leading countries like the United States in creating new businesses.

While the majority of Australians have benefitted from economic growth, the benefits have been unequally distributed.[6] Stagnant wage growth over the past decade, coupled with strong house price growth, has left many Australians, particularly in younger generations, feeling left behind.[7] A growing and ageing population is placing greater stress on Australia's cities, infrastructure and government services.[8] There is evidence that some aspects of Australia's educational performance are falling, both in absolute terms and relative to peers.[9]

Perhaps most importantly, trust in both public[10] and private institutions[11] has fallen sharply.

How well Australia manages these global and national challenges will have a significant effect on its future economic, environmental and social well-being.

2 OECD (2017) OECD economic surveys: Australia, Overview. OECD
3 Shorrock A, Davies J, Lluberas R (2018) Global Wealth Report 2018. Credit Suisse
4 The Economist Intelligence Unit (2018) The global liveability index 2018. The Economist Group
5 Australian Bureau of Statistics (2010) 1301.0 – Year Book Australia, 2009–10. Australia's biodiversity. Australian Government
6 Davidson P, Saunders P, Phillips J (2018) Inequality in Australia 2018. Australian Council of Social Service, University of New South Wales (2018)
7 Daley J, Coates B (2018) Housing affordability: re-imagining the Australian dream. Grattan Institute
8 Infrastructure Australia (2018) Future cities: planning for our growing population. Australian Government
9 Thomson S, De Bertoli L, Underwood C (2015) PISA 2015: A first look at Australia's Results. Australian Council for Educational Research
10 Cameron S, McAllister I (2016) Trends in Australian political opinion: results from the Australian Election Study 1987–2016. Australian National University
11 Edelman (2018) 2018 Edelman Trust Barometer global report. Edelman

Australia's choice: Positive *Outlook Vision* or *Slow Decline*

This report focuses on two contrasting scenarios: *Outlook Vision*, which represents what could be possible if Australia can achieve its full potential, and *Slow Decline*, in which Australia fails to adequately address the challenges identified, leading to poorer outcomes in multiple dimensions. There are three main points to consider in striving for *Outlook Vision*.

THE UPSIDE FOR AUSTRALIA IS SIGNIFICANT

GDP per capita could be as much as 36% higher in the positive *Outlook Vision* while ensuring that growth is inclusive and environmentally sustainable. Greenhouse gas emissions could be reduced to 'net zero' by 2050 while still maintaining strong economic growth and energy affordability. Australia's major cities could increase in density to handle a larger population while still retaining high liveability and access to services.

IT IS ACHIEVABLE ACROSS A RANGE OF GLOBAL CONTEXTS

To account for global uncertainties beyond Australia's immediate control, fractious and cooperative global contexts are considered. Outlooks that feature strong global cooperation on trade and climate change lead to the best environmental outcomes for Australia, without significantly affecting economic growth. But Australia needs to be adaptable and prepared to deal with the full range of possible global contexts.

IT'S WITHIN AUSTRALIA'S GRASP, BUT REQUIRES ACTION AND LONG-TERM THINKING ACROSS A RANGE OF IMPORTANT ISSUES

The *Outlook Vision* represents what is possible, but it will not be easy to achieve and will require action. Starting today, Australia will need to undergo five major shifts in: industrial composition, urban development, energy, land use and culture. For each of these shifts, there are key levers (or drivers). The shifts also present current problems and weaknesses, which suggest that Australia is not well prepared and that action is required to avoid the *Slow Decline* scenario. The nature of the shifts and the potential benefits they bring are also complementary – actioning one shift will positively impact others.

Report methodology

The report was developed over more than two years using a highly collaborative approach that combined input from the National Outlook participants with quantitative modelling and qualitative analysis from CSIRO (Figure 1).

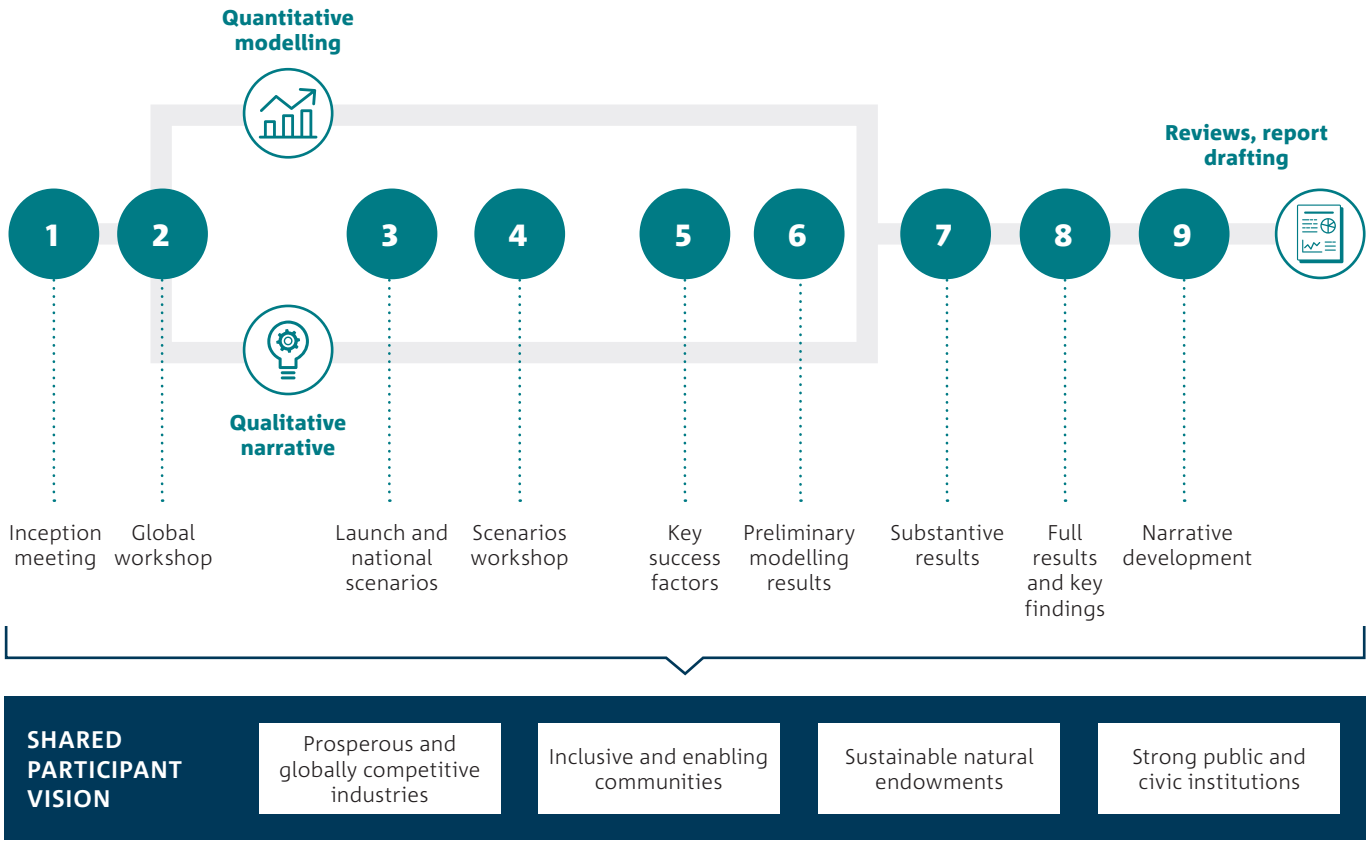
In early workshops, participants prioritised the global and national issues they thought were most important to Australia's future success. This started with a broad environmental scan that initially identified well over 100 issues, and ultimately settled on a shortlist of national issues across three main areas: productivity and services, cities and infrastructure, and natural resources and energy.

It should be noted that there was no attempt to cover every possible issue facing Australia. For example, while the cost of climate change mitigation (reducing greenhouse gas emissions) has been incorporated in national results, the costs and benefits of adaptation have limited representation and are generally underestimated due to the complexity of the modelling involved.

Furthermore, this report does not canvass all of the necessary contributing factors to a growing and vibrant economy, which will be key to Australia's future. These include, but are not limited to: tax reform, policies and incentives to create investment and research, good budgetary policy and continued focus on ensuring Australia remains globally competitive and not overly burdened with unnecessary regulation. Although important, these issues have been the subject of considerable public discussion elsewhere.

The national issues identified by participants were combined with two different global contexts to construct a number of scenarios that describe a range of possible futures Australia could face. Again, a collaborative workshop process was used to gather participant input on these scenarios. The qualitative and quantitative outcomes for individual issues were developed with participant guidance and CSIRO research using existing projections, published literature and recent trends and stretch targets to support the more ambitious outcomes.

FIGURE 1: NATIONAL OUTLOOK PARTICIPANT WORKSHOPS



These scenarios are possibilities rather than predictions for Australia. They are also not the only possible outcomes. The two scenarios described – *Slow Decline* and *Outlook Vision* – were chosen by participants to show a strong contrast between two vastly different possible outcomes for Australia.

Each of these scenarios was modelled to 2060 using CSIRO's integrated modelling framework, which combines multiple domain-specific economic and environmental models and builds on the research approach developed for the *Australian National Outlook 2015*.[1] Qualitative and quantitative analysis provided greater detail in domains not covered by this framework (particularly social and urban outcomes).

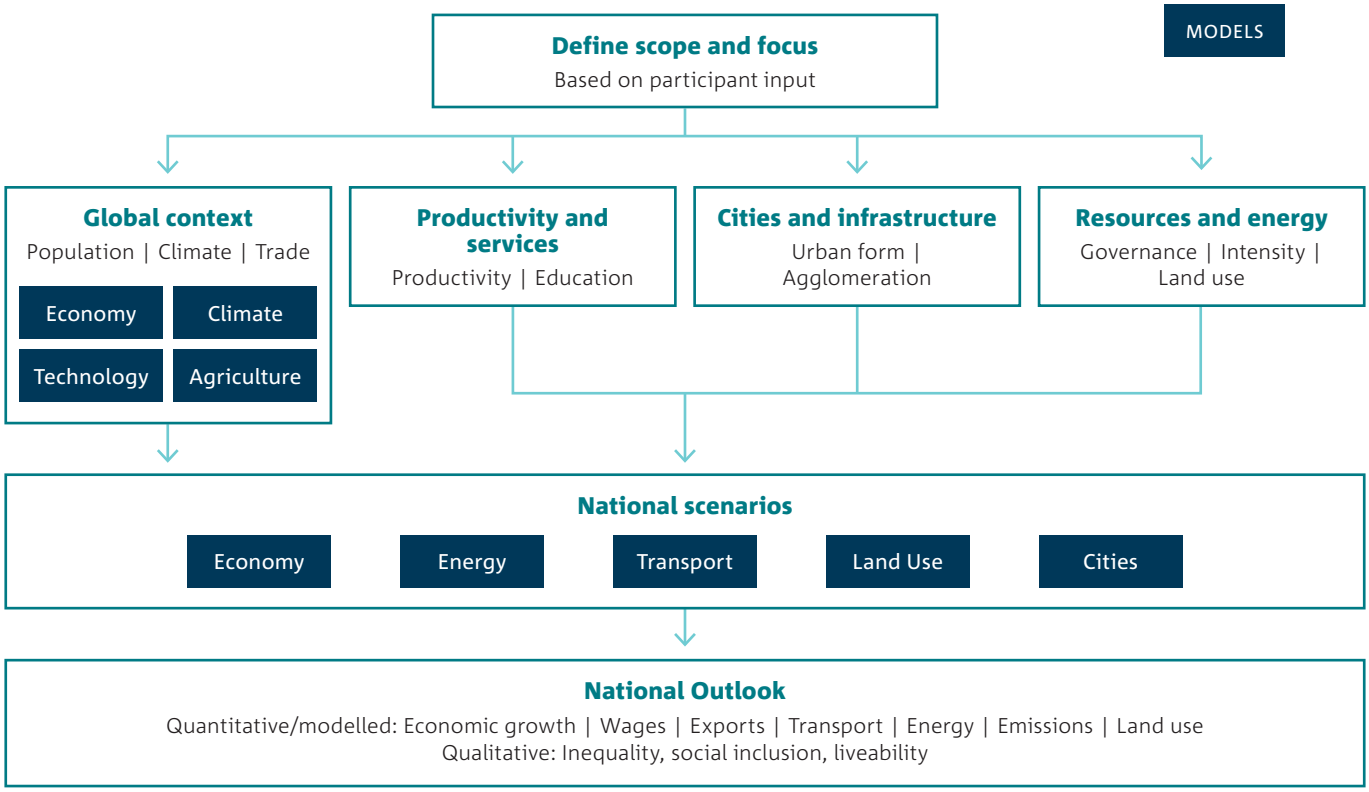
This integrated modelling framework allows for holistic analysis across domains. For example, in addition to taking productivity growth and investment into account, economic outcomes also factor in the effects of urban agglomeration (clustering around hubs and self-reinforcing urban growth) energy productivity, land use shifts and the cost of climate change mitigation (Figure 2).

Through an iterative, collaborative process, CSIRO worked with participants to interpret these modelled results, drawing on their expertise in areas such as finance, energy, construction, sciences and community services. This led to the main levers (or actions) that would be necessary to achieve the outcomes in the *Outlook Vision*. These levers ultimately formed the basis for the five shifts described in this report.

Throughout this process, participants considered a number of different viewpoints and openly debated how to interpret the evidence provided by CSIRO. In most cases, the group was able to reach a consensus, which is expressed in this report.

Section 2 outlines the challenges Australia faces in greater detail, Section 3 shows the strong contrast in outcomes between the main scenarios, and Section 4 describes the five shifts and their levers to deliver a more prosperous Australia. For more detail regarding the methodology, issues and assumptions underpinning these scenarios, readers are referred to the *Australian National Outlook 2019: Technical report*.[12]

FIGURE 2: NATIONAL OUTLOOK METHODOLOGY



12 Brinsmead T, Rendall A, Baynes T, Butler C, Kelly R, Adams P, Hayward J, Reedman L, Nolan M, Hennessy K, Wynn K, Ahmad ME, Marcos-Martinez R, Collins L, Lu Y, Che N, Qiu J (2018) Australian National Outlook 2019: Technical report. CSIRO

2 The challenges ahead

Australia's past successes and good fortune mask a number of underlying challenges that are already taking hold or on the horizon. When combined, they create even greater risks to Australia's ability to maintain a strong, vibrant market economy, protect the health of the natural environment and continue to improve the wellbeing of all Australians. National Outlook participants viewed the following as most important to Australia's future success:

Rise of Asia

Technological change

Climate change and environment

Demographics

Trust

Social cohesion

Each of these challenges also presents an opportunity for Australia to develop new sources of economic growth, protect its landscapes and marine ecosystems, and allow future generations of Australians to enjoy an even higher standard of living than today.

2.1 Rise of Asia

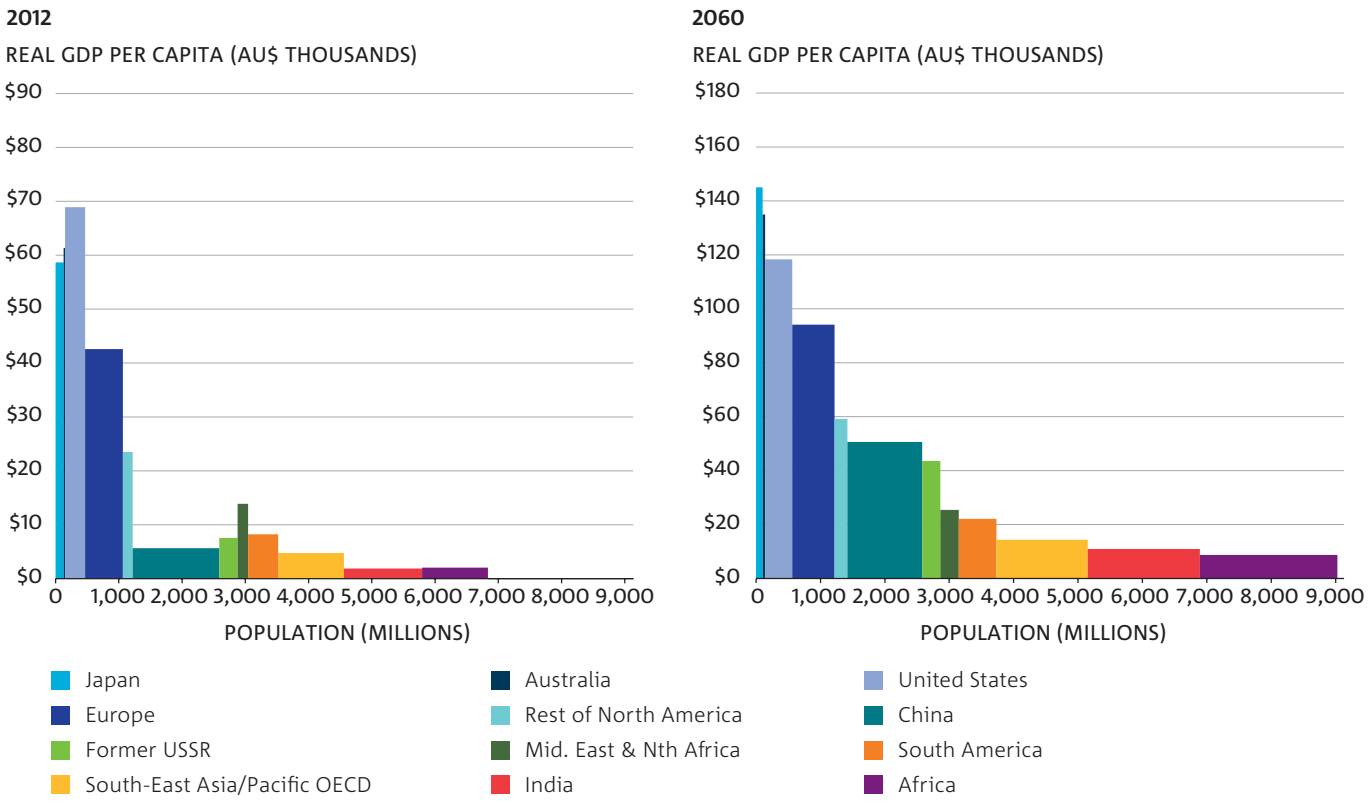
Global population and GDP are projected to grow strongly to 2060. This is especially true of China, where GDP per capita is projected to increase ninefold from 2012 to 2060 (Figure 3). Although the development boom in China that fuelled strong demand for Australian commodities is starting to taper off, China's economy is transitioning into a new phase of growth, fuelled by domestic consumption and services. This transition is expected to benefit global trade; however, given the size of China's economy, its prominence in global trade and the complexity of such a transition, it could be a rocky process with negative economic spillover effects.[13]

This transition in Asia creates both challenges and opportunities for Australia. The challenge comes because although Australia has a diversified domestic economy, eight of Australia's top 10 goods and services exports are related to minerals, energy or agriculture.[14]

In the long run, Australia's reliance on these exports may not be sustainable. For example, over the next two years the value of resource and energy exports is projected to decline, followed by an extended earnings plateau due to previous mining investments having reached full output and a lack of new projects and investments on the horizon.[15]

However, growth in Asia could create significant opportunities for Australia. By 2030, the Asia–Pacific region is set to consume more than half the world's food, 40% of its energy[16] and be home to an estimated 65% of the world's middle class,[17] extending the opportunities for Australia's quality product and service exports. Increased demand is forecast for a range of sophisticated goods and a broader range of services, such as tourism, education, health and aged care, entertainment and financial and professional services.[18] Capitalising on these opportunities will depend, in part, on Australia sensibly negotiating its geopolitical relationship with China.

FIGURE 3: RISING PER CAPITA GDP AND POPULATION ACROSS THE GLOBE COMPARING 2012 (LEFT) TO 2060 (RIGHT)



This figure shows population and GDP per capita across the globe in real terms at purchasing power parity from 2012 to 2060 under the Nation First global context scenario. Details on global context assumptions are discussed in Chapter 3 of the *Australian National Outlook 2019: Technical report*.[12]

13 International Monetary Fund (IMF) (2016) World economic outlook: too slow for too long. IMF
14 Department of Foreign Affairs and Trade (2019) Composition of Trade Australia 2017-18. Australian Government
15 Department of Industry, Science and Innovation, Office of the Chief Economist (2018) Resources and energy quarterly, March 2018. Australian Government
16 Australian Government (2017) Foreign policy white paper. Australian Government
17 Kharas H (2017) The unprecedented expansion of the global middle class: an update. Brookings Institution, Washington DC
18 Australian Government (2012) Australia in the Asian century white paper. Australian Government

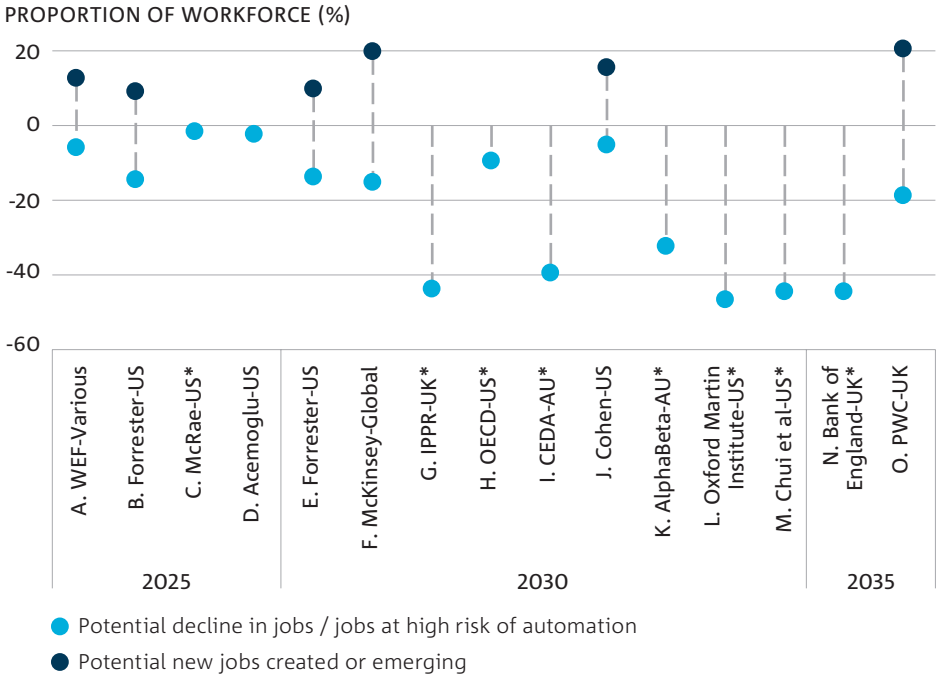
2.2 Technological change

New disruptive technologies are transforming industries and the way people live. The next wave of digital technologies, such as automation and artificial intelligence, has been heralded as the Fourth Industrial Revolution, and is expected to change the way people live, work and interact with one another.[19] Additive manufacturing (or 3D printing) is already enabling manufacturers to competitively produce complex, low-volume and high-margin products. Advanced materials are creating opportunities for products and parts with more desirable characteristics, such as those that are lightweight, stronger, conductive and self-healing.[20] Advances in precision medicine, which includes genomics and gene-editing technologies, are set to transform health care by optimising disease prevention and early intervention, and support advances in fields such as agriculture, environmental science and defence, among others.[21]

These same technologies are also changing the skills that will be needed in the workforce of tomorrow. This change is most apparent in information technology, with considerable attention being placed on data and digital skills and how digital technologies will affect jobs. Figure 4 shows the large variation in predictions of changes in jobs. Because of these uncertainties, a strong and agile education system is more important than ever before. In the face of declining academic results,[9,22] Australia faces difficulties in ensuring the workforce is prepared for the jobs of the future.

The World Economic Forum's latest jobs report stresses that if adaptation strategies are in place, embracing technology can have a net positive outlook for jobs, with job creation outweighing displacement.[23] As more workers move into the digital space, teaching methods, curricula and workplaces need to adapt to support Australia's future workforce and ensure a beneficial and inclusive transition.

FIGURE 4: PREDICTIONS OF THE EFFECTS OF AUTOMATION ON JOBS[24]



This figure shows the range of predictions regarding changes in jobs based on a systematic review of the estimated effects of technological change on employment. Using various methodologies ranging from task-based frameworks and historical evidence to more flexibly defined qualitative approaches, a large range of effects of automation on job numbers has been proposed in Australia, the world and specific countries. As can be seen in the figure, there were considerable variations in predictions, with some studies predicting an increase in jobs (of up to approximately 20%), some predicting a net zero effect on jobs and others predicting a decrease in jobs (of up to approximately 50%). Please note that the studies presented in Figure 4 are only a sample of existing literature to-date and were selected to demonstrate the variability in predictions in a concise manner. Also note that estimates reported are distinct from net changes in jobs. Most papers (marked with an asterisk) report potential job declines or jobs that are at high risk of automation.

19 Schwab K (2016) The Fourth Industrial Revolution: what it means, how to respond. World Economic Forum

20 CSIRO Futures (2016) Advanced manufacturing: a roadmap for unlocking future growth opportunities for Australia. CSIRO

21 Williamson R, Anderson W, Duckett SJ, Frazer IH, Hillyard C, Kowal E, Mattick JS, McLean CA, North KN, Turner A (2018) The future of precision medicine in Australia. Australian Council of Learned Academies

22 Australian Government (2018) Through growth to achievement: report of the review to achieve educational excellence in Australian Schools. Australian Government

23 World Economic Forum (2018) The future of jobs report. Centre for the New Economy and Society

24 (A) World Economic Forum (2018) The Future of Jobs Report 2018; (B) Forrester (2016) Robots, AI will replace 7% of US jobs by 2025; (C) McRae M (2017) Unsettling New Statistics Reveal Just How Quickly Robots Can Replace Human Workers (D) Acemoğlu D, Restrepo P (2017) Robots and jobs: Evidence from the US; (E) Forrester (2017) The Future Of Jobs, 2027: Working Side By Side With Robots; (F) Manyika J, Lund S, Chui M, Bughin J, Woetzel J, Batra P, Ko R, Sanghvi S (2017) Jobs Lost, Jobs Gained: Workforce transitions in a time of automation; (G) Lawrence M, Roberts C, King L (2017) Managing Automation: Employment, inequality and ethics in the digital age; (H) Nedelkoska L, Quintini G (2018) Automation, skills use and training; (I) CEDA (2015) Australia's future workforce?; (J) Wartzman R (2016) 25 Million New Jobs Coming to America; (K) AlphaBeta (2015) The Automation Advantage; (L) Frey CB, Osborne MA (2013) The Future of Employment: How Susceptible are Jobs to Computerisation?; (M) Chui M, Manyika J, Miremadi M (2015) Four fundamentals of workplace automation; (N) Haldane A (2015) Labour's Share, speech given to Trades Union Congress; (O) Hawksworth J, Fertig Y (2018) What will be the net impact of AI and related technologies on jobs in the UK?

2.3 Climate change and environment

Australia is the world's most arid continent, with a highly variable climate. Its diverse environment provides valuable services but also significant challenges. Today Australia's industries – particularly agriculture – have and continue to adapt to the environmental factors they encounter, but it is increasingly difficult.

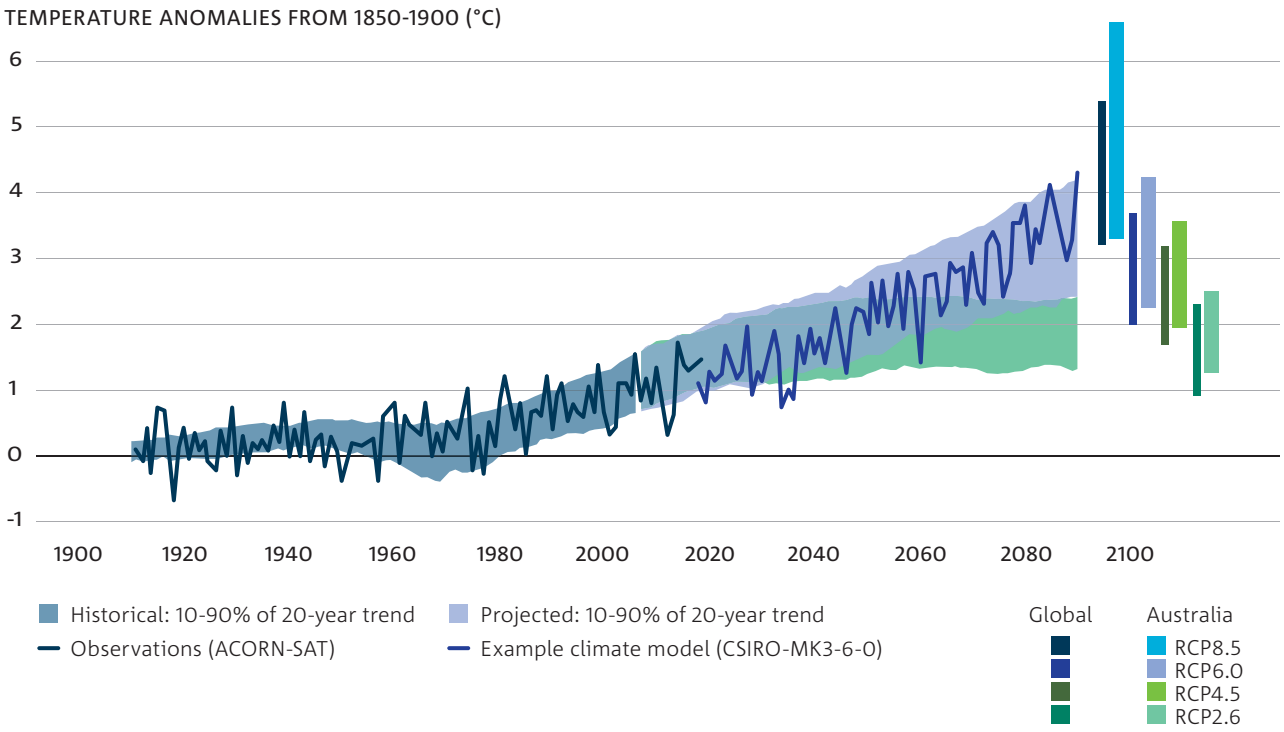
Since 1950 Australia has become warmer, with less rain in the south and more in the north, accompanied by large variability from year to year.[25]

Undoubtedly increases in greenhouse gases due to human activities are having an impact on the Australian and global climate.[26] Without significant action to reduce greenhouse gas emissions, the world could be on a path to a 4°C global warming since pre-industrial times (or worse) by 2100 (Figure 5)[27] radically changing the way we live, for the worse.

Global warming could be limited to 1.5°C or 2°C,[28] reducing the severity of the effects of climate change, but that would require significant action to reduce emissions, consistent with the Paris Agreement. We are beyond the ability to eliminate the effects of climate change.

As a result of global climate change, further warming is expected to occur in Australia over the course of the 21st century, causing a broad range of impacts, the severity of which will depend on the effectiveness of global emission reductions and local adaptation.[25,26]

FIGURE 5: AUSTRALIAN TEMPERATURE RECORD AND PROJECTIONS



This figure shows a time series of Australian average annual temperature anomalies from 1910 to 2100 relative to a baseline approximating pre-Industrial conditions (the 1850–1900 average). It includes observations, the range from the Coupled Model Inter-comparison Project phase 5 (CMIP5) set of global climate models and an example model. Future projections use the Intergovernmental Panel on Climate Change's (IPCC) emissions scenarios, termed Representative Concentration Pathways (RCPs). The bars on the right-hand side show the average for each RCP in 2080–99 globally (thin bars) and in Australia (thick bars). For more details on data sources and methods, visit www.climatechangeinaustralia.gov.au

25 BoM and CSIRO (2018) State of the Climate 2018 http://www.bom.gov.au/state-of-the-climate

26 Reisinger A, Kitching RL, Chiew F, Hughes L, Newton PCD, Schuster SS, Tait A, Whetton P (2014) Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press

27 The IPCC base their temperature forecasts on four scenarios called Representative Concentration Pathways (RCPs) that use scenarios of emissions and concentrations of greenhouse gases, aerosols, land-use and chemically active gases as shown in Figure 5. The Australian National Outlook selected two of these scenarios (RCP 2.6 and 6.0) as input to ANO's modelling scenarios. These upper-limits of the global warming range from RCP2.6 and RCP6.0 are 2°C and 4°C, respectively, by 2100 relative to 1850-1900 (pre-industrial). See Australian National Outlook 2019 – Technical Report for detail

28 IPCC (2018) Global warming of 1.5C. Summary for Policymakers, 34 pp http://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf

These impacts include more extremely high temperatures, fewer extremely low temperatures, less rainfall and more droughts in the south of the country. Climate changes in Australia are also projected to result in less snow, more intense rain events, more extreme fire weather, fewer but stronger cyclones, continued sea level rise and ocean acidification. Together these changes will have a significant effect on agriculture, forestry, fisheries, water security, energy security, infrastructure, transport, health, tourism, finance and disaster risk management.

These changes will also increase the stress on Australia's ecosystems, which are already threatened.[29] Australia is considered to be one of the world's mega-diverse countries. However, over the past 200 years, Australia has lost more species than any other continent, and continues to have the highest rate of species decline among OECD countries.[5]

Making matters worse, the legacy of intensive agriculture on a fragile environment continues to be felt in Australia's soils. Although farmers have made important advances in land management, acidification is at worrying levels in many lighter soils, soil carbon levels remain historically low and the risk of erosion increases with an increasing frequency of droughts and lower groundcover. These processes threaten productivity and reduce crop choice.[30,31]

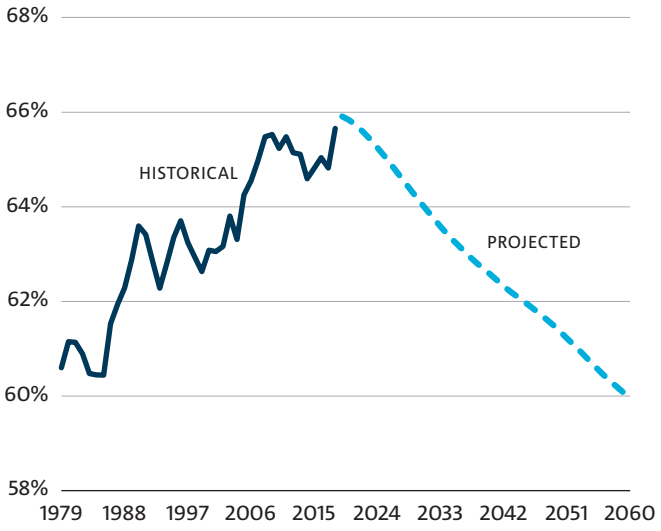
It is possible to strive towards zero emissions, dramatically reducing our impact and contribution to global warming, through a range of actions that target key sectors such as energy, land-use, urban infrastructure and industrial systems. Science, technology and an innovative spirit are already driving breakthroughs. For example, the CSIRO has pioneered the transformation of hydrogen as a renewable fuel source, and has shown that a new feed, FutureFeed, will lower emissions from cattle.

2.4 Demographics

Australia's population is projected to continue growing strongly, with an estimated population of 41 million by 2060.[32] The increase in population will be accompanied by an ageing of the population, reducing the proportion of working age people (15–64 years) from 66% in 2018 to an estimated 60% in 2060 (Figure 6).[33,34] While there are uncertainties, projections for labour participation, population growth and ageing are expected to affect economic output and infrastructure requirements and place pressure on government budgets.[34]

The ramifications of population growth are likely to be felt most strongly in urban environments, with both Sydney and Melbourne projected to become home to 8–9 million people (similar to London today), and the populations of Brisbane and Perth both increasing to 4–5 million people (similar to Sydney today). If Australian cities retain their relatively low population densities, city boundaries will need to expand. As populations are added to the periphery, more and more people will be distanced from jobs, higher education, health services and transport.

FIGURE 6: PERCENTAGE OF THE AUSTRALIAN POPULATION AGED 15–64 YEARS



This figure shows the historic proportion of people of working age (15–64 years), sourced from the Australian Bureau of Statistics (ABS),[33] followed by projections from the Productivity Commission[34] indicating a fall in the proportion of working age Australians to 60% in 2060.

29 Dunlop M, Hilbert DW, Ferrier S, House A, Liedloff A, Prober SM, Smyth A, Martin TG, Harwood T, Williams KJ, Fletcher C, Murphy H (2012) The implications of climate change for biodiversity conservation and the national reserve system: final synthesis. A report prepared for the Department of Sustainability, Environment, Water, Population and Communities, and the Department of Climate Change and Energy Efficiency. CSIRO Climate Adaptation Flagship

30 FAO, Intergovernmental Technical Panel on Soils (ITPS) (2015) Status of the World's Soil Resources (SWSR) – main report: FAO and ITPS

31 Metcalfe DJ, Bui EN (2017) Australia state of the environment 2016: land. Independent report to the Australian Government Minister for the Environment and Energy, Australian Government Department of the Environment and Energy, Canberra. doi:10.4226/94/58b6585f94911

32 Australian Bureau of Statistics (ABS) (2013) ABS Population Projections Series B, Australia, 2012 (base) to 2101 ABS 32220. ABS, Canberra

33 Australian Bureau of Statistics (ABS) (2018) 6202.0 – Labour Force, Australia: Table 1. ABS, Canberra

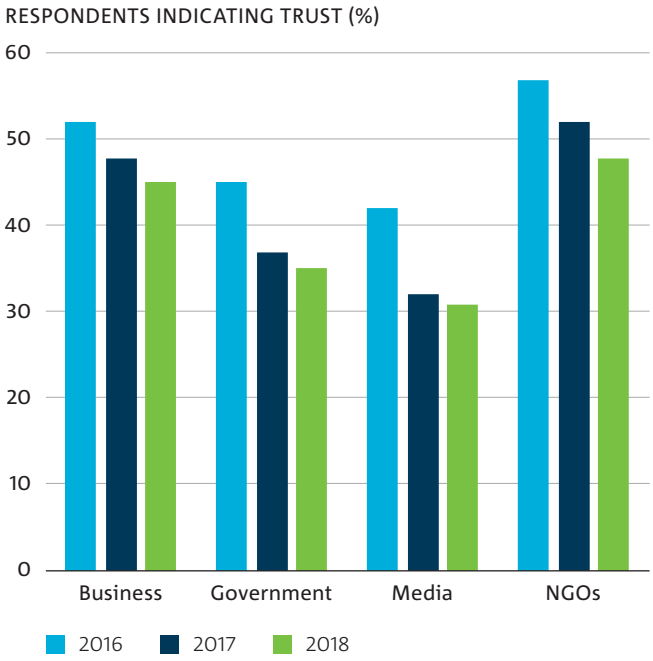
34 Productivity Commission (2013) Productivity Commission Research Paper, An Ageing Australia: Preparing for the Future. Australian Government

2.5 Trust

Trust in institutions (governments, businesses, non-governmental organisations (NGOs) and the media) has declined in recent years, particularly in Western democracies (Figure 7).[11] Australia has not escaped this trend, with the percentage of people who say they trust government falling from 42% in 1993 to just 26% in 2016.[10] Trust in business has been largely stagnant, but has fallen in recent years, with 45% of respondents in the 2018 Edelman trust survey expressing trust, and only 39% of respondents rating CEOs as very or extremely credible.[11] This loss of trust threatens the social license to operate for Australia's institutions, restricting their ability to enact long-term strategies.[35]

The reasons behind the decline stems from a range of factors. For industry, some of these factors include a desire for more action from business leaders to act beyond short-term financial gains, including by keeping promises and disclosing mistakes. This is growing against a backdrop of operational transparency issues that continue to attract poor perceptions.[36] It has been suggested that governments are seen to be losing trust because representatives are perceived to over-promise, under-deliver and be unrepresentative, whereas the line between them and business continues to be blurred due to the nature of political donations and the movement of politicians into post-political lobbyist roles.[37]

FIGURE 7: TRUST IN AUSTRALIAN INSTITUTIONS[11]



This figure shows the percentage of respondents that indicated they had trust in an institution to do what is right. A list of institutions was supplied and, for each one, general population respondents were asked to indicate how much they trusted that institution to do what is right using a nine-point scale (1 = do not trust them at all; 9 = trust them a great deal). Edelman recently published their 2019 Trust Barometer, which showed a small rebound in trust compared with the 2018 results. However, trust remains a significant issue for Australian institutions.

35 Australian Institute of Company Directors, KPMG (2018) Maintaining the social licence to operate. KPMG
36 Deloitte (2018) The way forward to rebuild reputation and trust, Deloitte Trust Index – banking 2018. Deloitte
37 Wood D, Daley J, Chivers C (2018) A crisis of trust: the rise of protest politics in Australia. Grattan Institute

2.6 Social cohesion

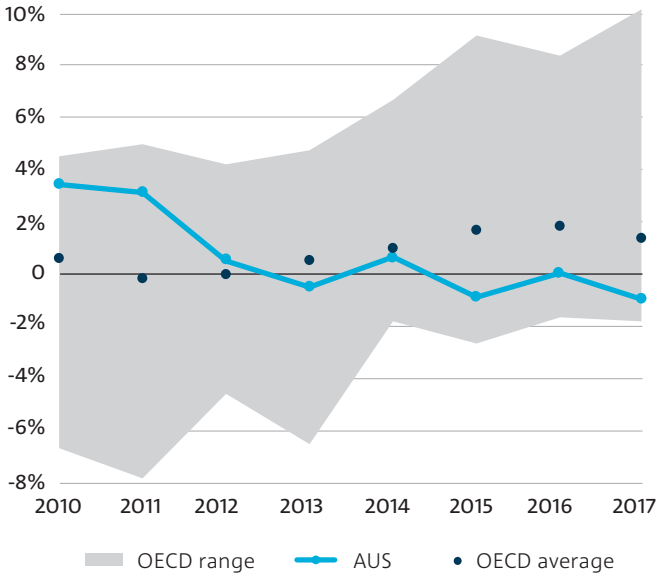
Although the concept of social cohesion has a long history and continues to evolve, it continues to be of fundamental importance when discussing consensus and conflict in society.[38] This belief is held by the Scanlon Foundation in Australia, an organisation that measures social cohesion annually using an index that takes into consideration respondents' sense of belonging and worth, social justice and equity, political participation and attitudes towards minorities and newcomers. This index has decreased over the life of the survey, falling from a baseline of 100 in 2007 to 88.5 in 2017.[39]

The drivers of social cohesion are not fully understood. Issues related to trust as well as factors such as financial stress, slow wage growth and poor housing affordability may all play a role. A recent University of New South Wales poll indicated that 11% of Australians are experiencing severe or high financial stress or vulnerability.[40] One reason for this could be real wage growth, which has fallen to near-historic lows and sits near the bottom of the OECD range (Figure 8). The Governor of the Reserve Bank of Australia remarked in a 2018 speech that low wage growth is diminishing Australia's sense of shared prosperity.[41]

Another contributing factor is declining housing affordability and its disproportionate effect on low income earners. The bottom 20% of households are spending more of their income on housing, cheaper housing has increased in price faster than more expensive housing and home-ownership rates are falling among the young and the poor.[7]

In 2018, the Productivity Commission concluded that over the last three decades, although sustained growth has significantly improved living standards in every income decile, inequality has risen slightly.[42] Importantly, there is more to inequality than variation in material living standards, particularly through its impact on the multiple dimensions of human capital and economic participation.[43]

FIGURE 8: REAL ANNUAL WAGE GROWTH TREND[44]



This figure shows historical annual wage growth trends in Australia compared with the OECD average against a backdrop of the range of OECD countries from 2010 to 2017.

These challenges are just a few Australia faces. Due to the intergenerational nature of these challenges, long-term planning and collective commitments are required to safeguard and prepare Australia for continued prosperity. Meeting these challenges presents an opportunity for Australia to develop new sources of inclusive economic growth that will open up opportunities for more Australians to enjoy an even higher standard of living than they enjoy today.

38 Jensen J (2010) Defining and Measuring Social Cohesion. Commonwealth Secretariat

39 The Scanlon Foundation (2017) Mapping social cohesion, the Scanlon Foundation surveys 2017. Monash University

40 Muir K, Reeve R, Connolly C, Marjolin A, Salignac F, Ho K (2016) Financial resilience in Australia 2015. Centre for Social Impact, UNSW, for the National Australia Bank

41 Lowe P (2018) Productivity, wages and prosperity. Available at https://www.rba.gov.au/speeches/2018/sp-gov-2018-06-13.html

42 Productivity Commission (2018) Rising inequality? A stocktake of the evidence. Australian Government

43 Schwandt H, von Wachter T (2019). Unlucky Cohorts: Estimating the Long-term Effects of Entering the Labor Market in a Recession in Large Cross-sectional Data Sets. Journal of Labor Economics, 37(S1), S161-S198

44 OECD.stat (2017) Annual average wages. Available at https://stats.oecd.org/Index.aspx?DataSetCode=AV_AN_WAGE

3 Australia's future can be bright: *Slow Decline* vs *Outlook Vision*

The previous section outlined the significant global and national challenges that pose a risk to Australia's future. How Australia responds to these challenges will determine, in large part, its future outcomes. This section draws on CSIRO's integrated modelling and research to quantitatively and qualitatively contrast the economic, environmental and social outcomes to 2060 for two different scenarios designed by National Outlook participants.

Without strong actions to address the challenges outlined in the previous section, Australia risks falling into a *Slow Decline*, with relatively poor economic, social and environmental outcomes. Alternatively, by taking decisive action and a long-term view, Australia can achieve much more positive outcomes, as described in the *Outlook Vision*. The difference between these two scenarios is significant and the positive outlook is worth striving for, even across a range of global scenarios.

These two contrasting scenarios are plausible, evidence-based narratives that explore a range of causes and effects, as well as the trade-offs between different outcomes. The scenarios were developed in consultation with the National Outlook participants; they are not intended to be predictions, nor should it be inferred that these are the only possible scenarios. In fact, a range of other scenarios was modelled as sensitivity analyses and decompositions of major results, details of which are available in the *Australian National Outlook 2019: Technical report*.[12]

Slow Decline

In *Slow Decline*, Australia drifts into the future. Economic growth, investment and education outcomes are all relatively weak. Australia's economy is increasingly vulnerable to external shocks. Total Factor Productivity (TFP) growth remains well below the global frontier and wage growth is relatively low.

Australia's cities sprawl outwards, making it more difficult for people in the outer suburbs to access jobs, education and services. Housing affordability remains a major concern. This deepens social divisions and polarisation. Trust in institutions remains low.

Although energy policy issues are resolved domestically, the low-emissions energy transition is stymied by a lack of global cooperation on climate change. Both energy and agricultural productivity remain relatively low.

GDP grows at **2.1%** annually

Real wages are **40% higher** in 2060 than today

Cities sprawl with **little change** in density

Average urban vehicle kilometres travelled per capita **falls by less than 25%**

Net emissions **decrease to 476 $MtCO_2e$** by 2060 (–11% on 2016 levels)

61% increase in **total energy use** by 2060 (on 2016 levels), with only a modest improvement in energy productivity

Households spend **38% less** on electricity as a percentage of income

Returns to landholders increase by around **$18 billion** between 2016 and 2060

Minimal environmental plantings in 2060

Outlook Vision

In the *Outlook Vision*, Australia reaches its full potential. Economic growth remains strong and inclusive as Australian companies use technology to move productivity towards the global frontier and create new globally competitive, export-facing industries. Improved educational outcomes give Australians the skills they need to compete in this technology-enabled workforce.

Australia's cities are dynamic and diverse global centres with higher-density populations, a diverse range of affordable housing options and equal access to high-quality jobs, recreation, education and other services.

Australia successfully transitions its energy system, with high reliability and affordability and lower emissions.

If the world cooperates to limit climate change to 2°C, Australia can go even further and reach 'net zero' emissions by 2050, driven by significant shifts in land use to carbon plantings.

GDP grows at **2.75–2.8%** annually

Real wages are **90% higher** in 2060 than today

Average density of major cities **increases 60–88%**

Average urban vehicle kilometres travelled per capita **reduced by 33–45%** with greater uptake of mass transit

Australia reaches **net-zero emissions** by 2050 under a cooperative global context, with the potential for net-negative emissions by 2060

6–28% increase in **total energy use** by 2060 (on 2016 levels) with more than a doubling of energy productivity per unit of GDP

Returns to landholders increase by **$42–84 billion** between 2016 and 2060

6–28%

64%

Households spend up to **64% less** on electricity as a percentage of income

11–20 Mha of environmental plantings in 2060 under a cooperative global context (12–24% of intensive agricultural land)

BOX 1: Considering the global context

The outcomes of the *Outlook Vision* are materially better than under *Slow Decline*. For the most part these outcomes are dependent on proactive choices in Australia that maintain a long-term perspective. However, the reality is that Australia's performance will be affected by global factors which may be outside of its control.

To explore differences in the global context, the *Outlook Vision* considers a fractious and a cooperative global context (Figure 9).

Under both the global contexts shown in Figure 9, the *Outlook Vision* is far better economically, environmentally and socially than *Slow Decline*. However, in a cooperative global context, Australia can achieve significantly better environmental outcomes without significantly affecting economic growth.

FIGURE 9: *OUTLOOK VISION* UNDER DIFFERENT GLOBAL CONTEXTS

Fractious global context

National and protectionist rhetoric stalls global trade, economic growth slows, population increases and there is no firm action on climate change, resulting in a global average temperature rise of 4°C by 2100.

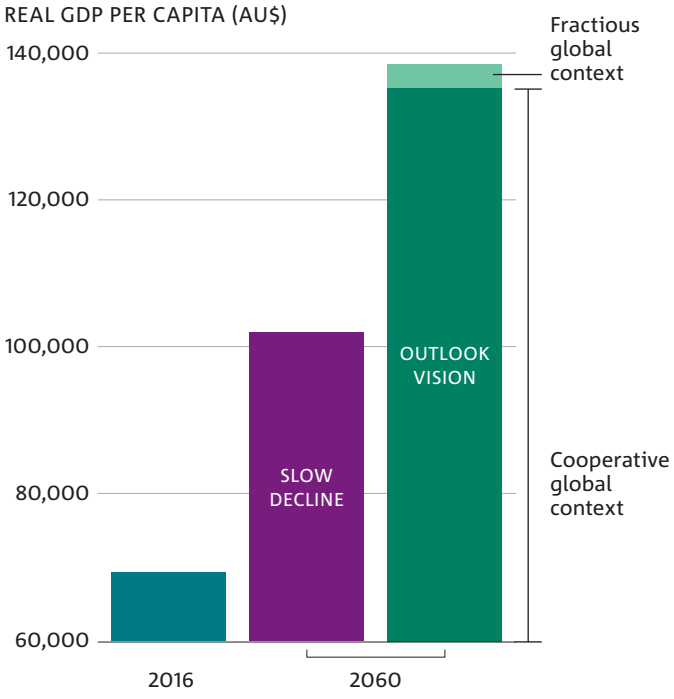
Cooperative global context

Global trade and geopolitical tensions are more positive than they are today, populations increase, but at the low end of projections, and there is effective global action on climate change to limit global average temperature rises to 2°C by 2100.

3.1 Economic outcomes

The comparisons between the *Outlook Vision* and *Slow Decline* are stark, even when considering the different global contexts (see Box 1). The *Outlook Vision* has Australian GDP growing at 2.75–2.8% annually, with GDP per capita 33–36% higher than under *Slow Decline* in 2060 (Figure 10), driven largely by total factor productivity (TFP) improvements (Figure 11). In real terms this equates to a GDP of between $5.5–5.6 trillion for the *Outlook Vision* depending on the global context compared with $4.1 trillion for *Slow Decline*.[45] Unemployment remains low and average wages are 35% higher than under *Slow Decline*, and 90% higher than today (Figure 12).

FIGURE 10: AUSTRALIA'S REAL GDP PER CAPITA

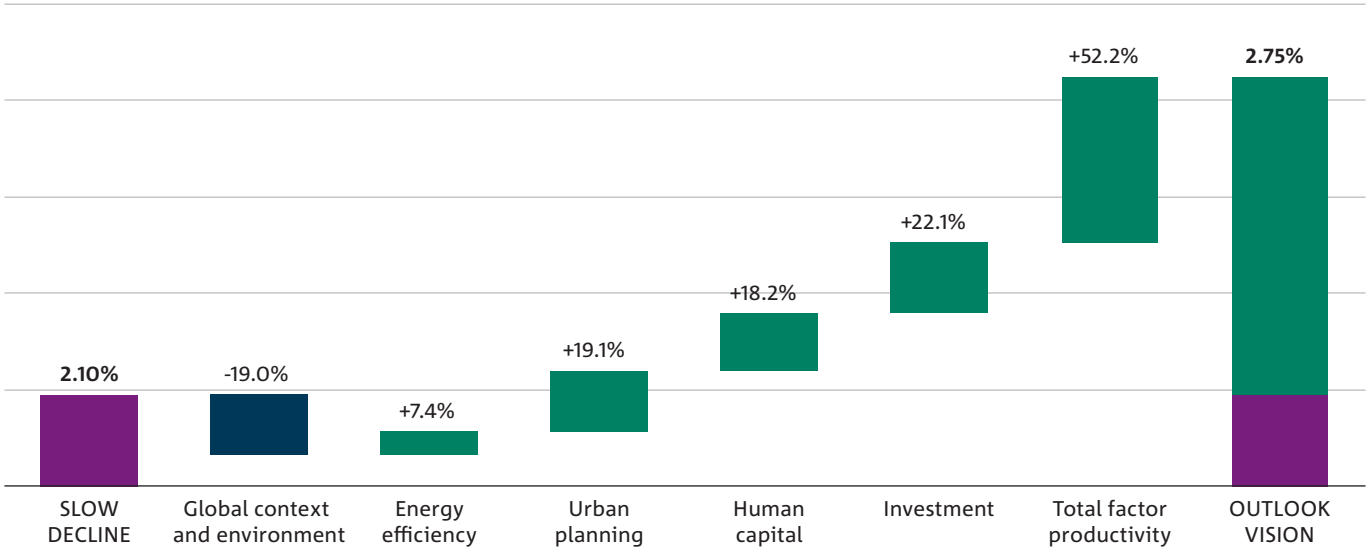


This figure shows Australia's real GDP per capita in 2016 and the modelled outcomes for *Slow Decline* and *Outlook Vision*. The two shades in the *Outlook Vision* column represent the range of outcomes possible depending on the global context, with the darker shade indicating outcomes under a cooperative global context and the lighter shade indicating outcomes under a fractious global context.

45 Note, unless specified otherwise, all values reported herein are in 2016 Australian dollars.

FIGURE 11: DECOMPOSITION OF ANNUALISED GDP GROWTH

% GDP GROWTH CONTRIBUTION

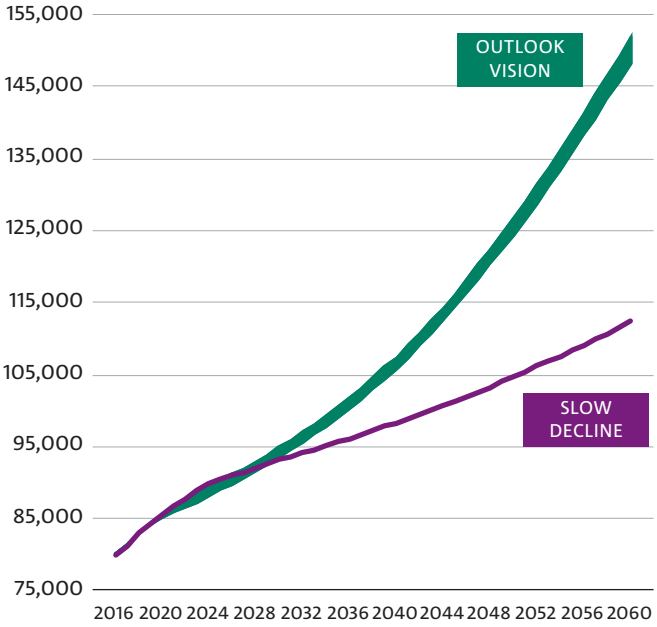


This figure shows a breakdown of the different components that contribute to the annualised GDP growth modelled between *Slow Decline* (2.10% under a fractious global context) and the *Outlook Vision* (2.75% under a cooperative global context). Although it is difficult to discuss moving a single element in isolation, this chart estimates the relative importance of primary model elements (drivers).

The *Outlook Vision* sees Australia become one of the most productive users of energy in the world, with GDP per unit of energy more than doubling, compared with just keeping up with the global average under *Slow Decline*. A market-driven global energy disruption occurs under both the *Slow Decline* and *Outlook Vision* scenarios, resulting in global demand for commodities like coal declining. Although a change towards a more cooperative global context would create a tougher trading environment for fossil fuels, the *Outlook Vision* assumes long-term decision making that helps build resilience to economic and technological shocks, and adaptability into the economy regardless of the global context. This helps open up new opportunities in the form of carbon farming, including carbon forestry on less-productive land, and the export of hydrogen produced with renewable energy resources.

FIGURE 12: AVERAGE WAGES IN AUSTRALIA UNDER THE *OUTLOOK VISION* AND *SLOW DECLINE* SCENARIOS

REAL WAGES 2016 (AU$)



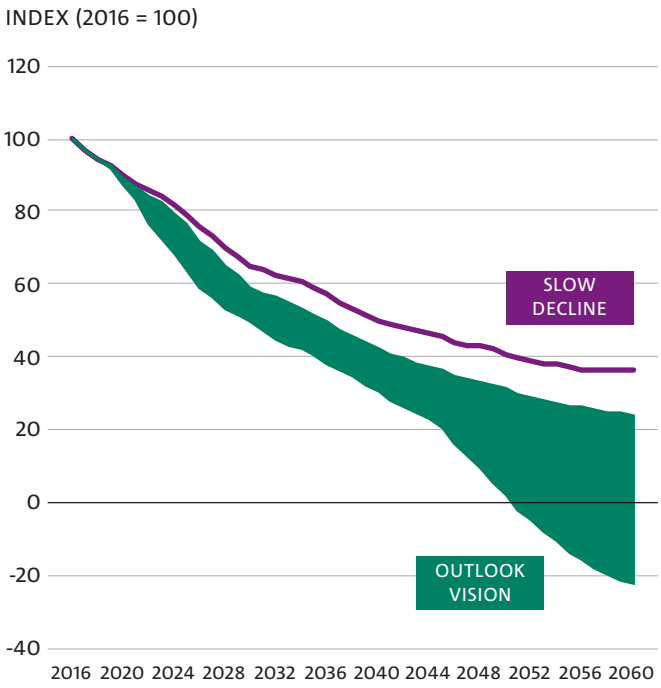
This figure shows modelled scenarios for real average wage growth from 2016 to 2060 under the *Slow Decline* and *Outlook Vision* scenarios. The shaded area of *Outlook Vision* represents the range of outcomes possible depending on the global context.

3.2 Environmental outcomes

More than any other aspect, environmental performance is contingent on the global context and global action on climate change to limit global warming to 2°C by 2100. Without global action on climate change, the world would be on a path to a 4°C global warming (or worse), and ecosystems would be under significant stress. In the absence of cooperative global action, the *Outlook Vision* achieves limited emissions reductions that are only marginally better than *Slow Decline* by 2060 in absolute terms. Most of the abatement in this context is due to emissions reductions in electricity generation and transport sectors of 98% and 36%, respectively. Importantly, the emissions intensity of GDP in the *Outlook Vision* declines relative to *Slow Decline* even in a more fractious global context, whereas economic growth is stronger throughout the period (Figure 13). This decoupling of emissions from GDP demonstrates that stronger action on environmental measures need not come at the expense of economic outcomes.

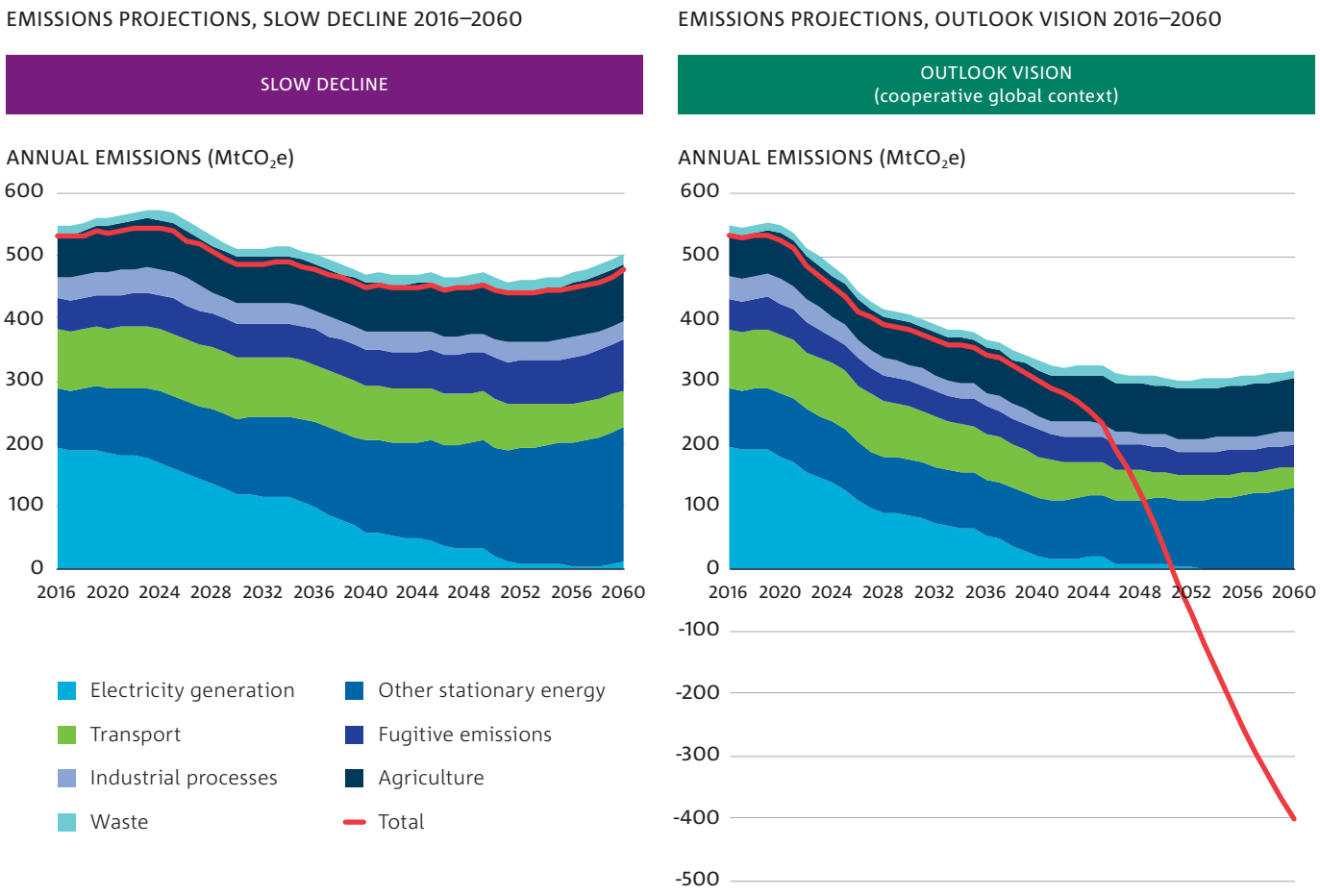
However, *Outlook Vision* outcomes could be far better under a cooperative global context with strong global action on climate change to limit global warming to 2°C by 2100. Lower emissions from energy and greater sequestration on the land could enable Australia to achieve 'net zero' emissions by 2050 under the *Outlook Vision* (Figure 14, Figure 15). With a focus on ecosystem restoration alongside carbon sequestration, the *Outlook Vision* results in 11–20 Mha of environmental plantings (i.e. native–endemic mixed environmental plantings that provide the most suitable habitat for biodiversity) by 2060, building resilience against future climate change. This translates to between 12% and 24% of intensive agricultural land (or between 32% and 42% of land used for carbon forestry) consisting of biodiverse native species. In the process, Australia can also capitalise on low-carbon export industries such as hydrogen, countering the likely decline in global demand for fossil fuels.

FIGURE 13: EMISSIONS INTENSITY OF GDP, 2016–2060



The figure demonstrates the relationship between greenhouse gas emissions and economic performance across the *Outlook Vision* and *Slow Decline* scenarios over time. The shaded area of the *Outlook Vision* represents the range of outcomes possible depending on the global context. Emissions intensity of GDP has been indexed at 2016. Due largely to the extensive potential for carbon farming under the carbon price assumptions of *Outlook Vision* in a cooperative global context, GDP per capita undergoes a significant 'decoupling' from emissions relative to *Outlook Vision* in a fractious global context and *Slow Decline*.

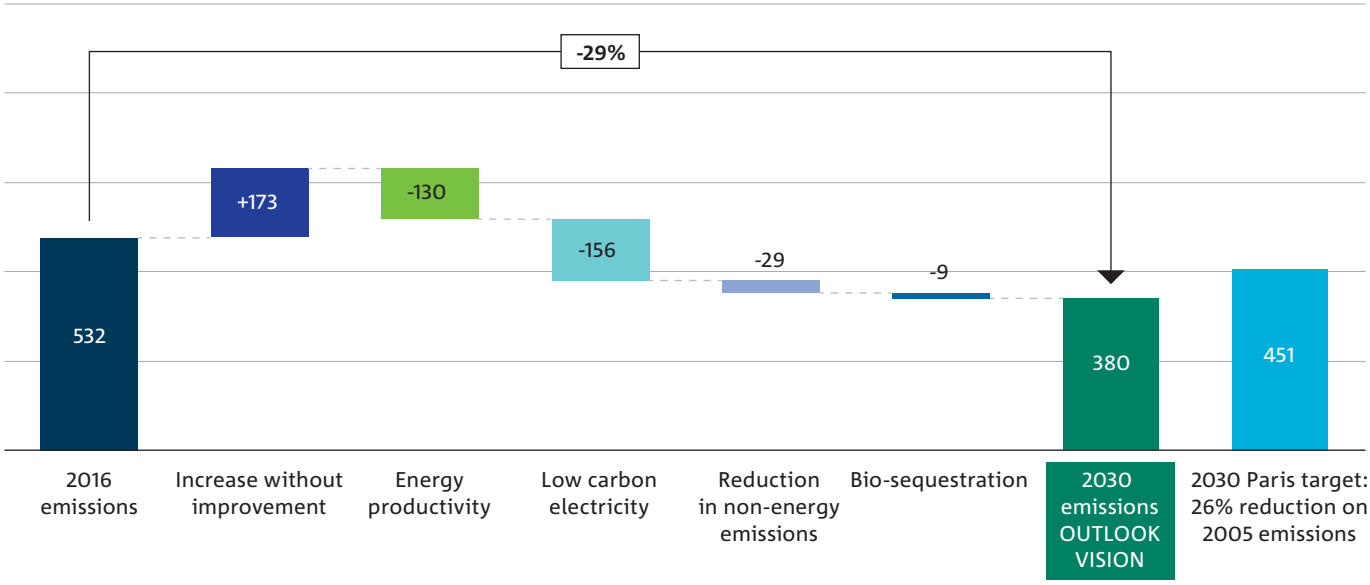
FIGURE 14: EMISSIONS PROJECTIONS UNDER THE *SLOW DECLINE* VERSUS *OUTLOOK VISION* SCENARIOS, 2016–2060



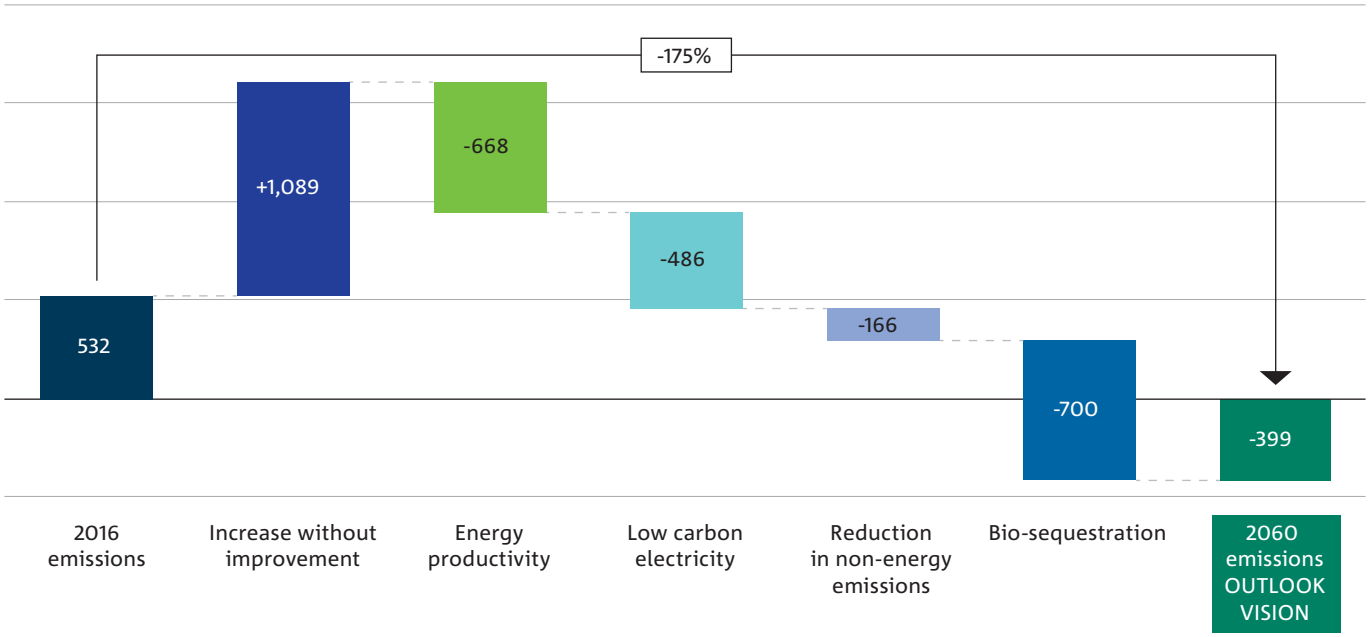
This figure shows emissions projections for *Slow Decline* and *Outlook Vision* (under a cooperative global context) from all sources, measured in million of tonnes of CO_2 equivalent ($MtCO_2e$). Other stationary energy is the consumption of energy other than electricity generation or transport fuel. It is mostly the direct use of fuels by industry, the majority of which is for the provision of heat by gas combustion. The red line represents 'net emissions' (i.e. the amount of carbon released minus the amount sequestered or offset. This includes consideration of a 'social lag' which refers to the rate of adoption of new land uses (with the change from agriculture to carbon plantings modelled in CSIRO's Land Use Trade Offs model to occur over 16 years from the year of profitability). For more details, see the *Australian National Outlook 2019: Technical report*.[12]

FIGURE 15: EMISSIONS BREAKDOWN

Change in Annual Emissions from 2016 to 2030



Change in Annual Emissions from 2016 to 2060



These figures show the breakdown of how emission levels (tonnes of CO_2 equivalent) will be achieved under the *Outlook Vision* in a cooperative global context, first on a timeline from 2016 to 2030 (top), followed by 2016 to 2060 (bottom). The contribution of each element to overall emissions has been estimated after modelling. The increase in emissions in the absence of improvement is estimated by increasing combustion and non-combustion emissions proportional to the change in activity across all sectors modelled. This is different to a business-as-usual interpretation, which will include some emissions reductions. Each element is estimated sequentially, in the order in which they appear on the chart. This approach ignores the interactions between elements, and so results would change depending on the order in which they are applied.

3.3 Social outcomes

Although not modelled,[46] the *Outlook Vision* assumes inclusive economic institutions and markets, defined on the basis of participant feedback and existing literature,[47,48] supported by a broader cultural shift. These inclusive institutions encourage people to participate in a choice of vocations that make best use of their skills, create opportunities for all, regardless of social and economic status at birth, and improve living standards while fairly sharing the benefits of increased prosperity. In the *Outlook Vision* these outcomes are supported through improvements in education, social inclusion and the rebuilding of trust in institutions. In comparison, *Slow Decline* assumes a growing social divide that is exacerbated by poorer educational outcomes and a failure to regain trust in public and private institutions.

In all scenarios, Australia's population increases to 41 million people by 2060, with the four largest cities increasing their share of population from 58% in 2016 to 66% (27 million people) by 2060. The key difference between the *Outlook Vision* and *Slow Decline* is how this population growth is managed. *Slow Decline* sees an expansion of capital city boundaries with a modest increase in Australia's currently low population density, most of which occurs in city centres. Conversely, in the *Outlook Vision*, Australia changes from low to medium density, with denser capital cities growing around multiple city 'centres', creating exciting, well-connected hubs with a greater variety of housing types located closer to jobs, services and amenities.

46 Social outcomes in this report have been explored through qualitative analysis and in a manner that is consistent with the *Slow Decline* and *Outlook Vision* scenarios.

47 Acemoglu D, Robinson J (2012) Why nations fail: the origins of power, prosperity and poverty. Crown Publishing Group

48 OECD (2015) All on board: making inclusive growth happen. OECD Publishing

4 Five key shifts to deliver a more prosperous Australia

Achieving the *Outlook Vision* will require significant effort and action. There are five core shifts that Australia will need to undergo to get there, and 'levers' that will have the most impact in each.

The shifts and levers are a synthesis of modelling and analysis of National Outlook participants' input, refined over multiple workshops. These levers are not exhaustive, or the only solutions to Australia's challenges, but they help articulate the types of changes, assumptions and actions required to achieve the ambitious outcomes in the *Outlook Vision*.

The nature of the shifts and the potential benefits they bring are also complementary, whereby the actioning of one shift sees benefits spread throughout others. For example, by actioning improvements in urban planning, benefits can flow through to GDP growth (see Figure 11), whereas land use changes can provide co-benefits for the energy shift (see Figure 15). Although not modelled, these shifts also contribute to improved social outcomes. Underpinning and empowering all of the above is the successful execution of a shift in culture throughout Australia's public and private institutions. Addressing this is critical to Australia's future success.

Five key shifts

INDUSTRY

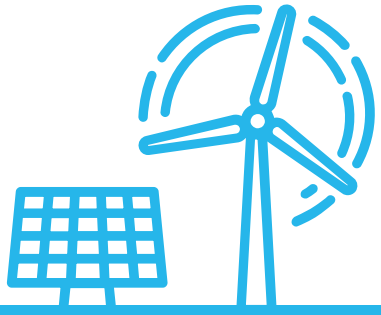
An INDUSTRY shift will enable a productive, inclusive and resilient economy, with new strengths in both the domestic and export sectors.

- Increase the adoption of technology to boost productivity in existing industries that have historically supported Australia's growth, as well as new industries.
- Invest in skills to ensure a globally competitive workforce that is prepared for technology-enabled jobs of the future.
- Develop export-facing growth industries that draw on Australia's strengths and build competitive advantage in global markets and value chains.

URBAN

An URBAN shift will enable well-connected, affordable cities that offer more equal access to quality jobs, lifestyle amenities, education and other services.

- Plan for higher-density, multicentre and well-connected capital cities to reduce urban sprawl and congestion.
- Create mixed land use zones with diverse high-quality housing options to bring people closer to jobs, services and amenities.
- Invest in transportation infrastructure, including mass-transit, autonomous vehicles and active transit, such as walking and cycling.



ENERGY

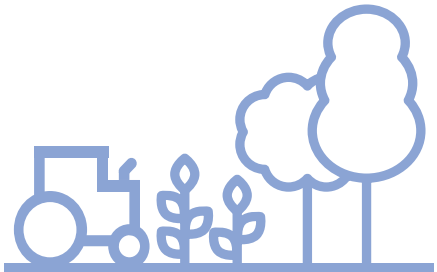
An ENERGY shift will manage Australia's transition to a reliable, affordable, low-emissions energy economy that builds on Australia's existing sources of comparative advantage.

- Manage the transition to renewable sources of electricity, which will be driven by declining technology costs for generation, storage and grid support.
- Improve energy productivity using available technologies to reduce household and industrial energy use.
- Develop new low-emissions energy exports, such as hydrogen and high-voltage direct current power.

2060

Outlook Vision

of an inclusive, resilient and prosperous economy



LAND

A LAND shift will create a profitable and sustainable mosaic of food, fibre and fuel production, carbon sequestration and biodiversity.

- Invest in food and fibre productivity by harnessing digital and genomic technology, as well as using natural assets more efficiently.
- Participate in new agricultural and environmental markets, such as carbon forestry, to capitalise on Australia's unique opportunities in global carbon markets.
- Maintain, restore and invest in biodiversity and ecosystem health, which will be necessary to achieve increased productivity.

CULTURE

A CULTURE shift will encourage more engagement, curiosity, collaboration and solutions, and should be supported by inclusive civic and political institutions.

- Rebuild trust and respect in Australia's political, business and social institutions.
- Encourage a healthy culture of risk taking, curiosity and an acceptance of fear of failure to support entrepreneurship and innovation.
- Recognise and include social and environmental outcomes in decision-making processes.

4.1 Industry shift: A revitalised, resilient economy

In the *Outlook Vision*, Australia has a productive, inclusive and resilient economy, with new strengths in both its domestic and export sectors.

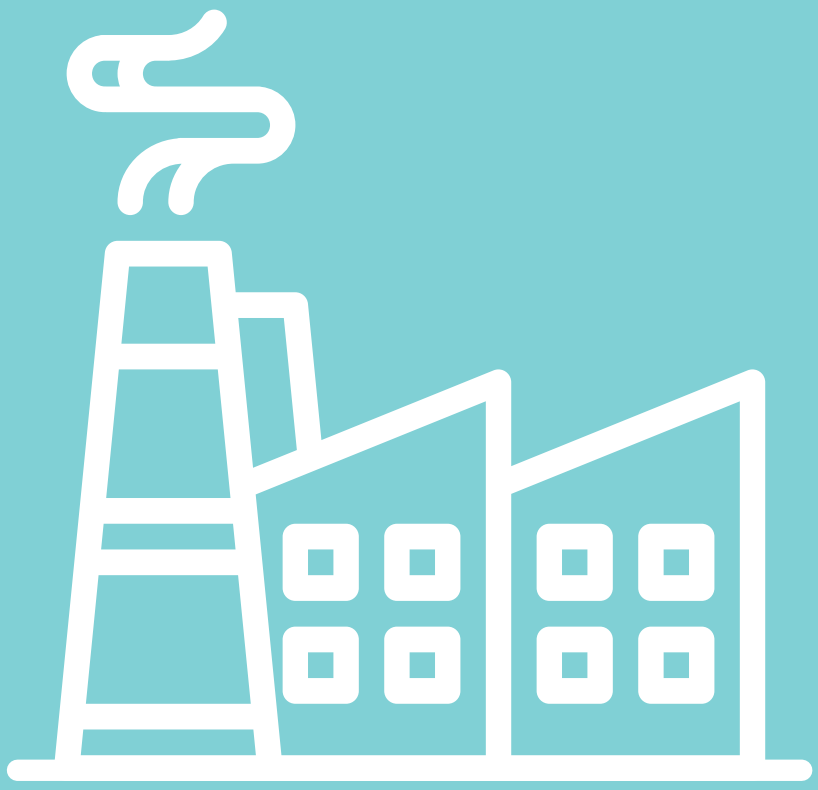
SELECTED *OUTLOOK VISION* MEASURES

2.8% per annum GDP growth rate.

Real wages are **90%** higher in 2060 than today.

Increased productivity accounts for **52%** of the difference in GDP growth.

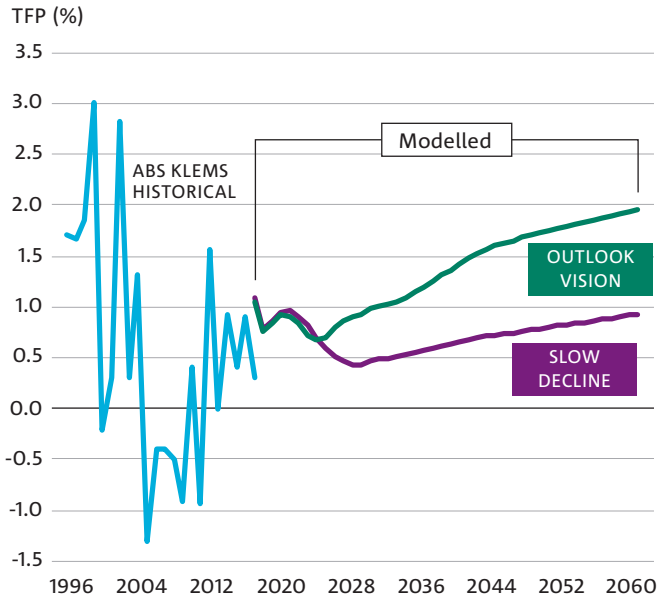
Investment and human capital contribute **22%** and **18%** of difference.



THREE LEVERS THAT SUPPORT A REVITALISED, RESILIENT ECONOMY INCLUDE:

- **Adopt technology:** maintain competitiveness of our historically strong industries through adoption of world-leading technologies and participation in global value chains. Collaborate across national sectors to spread those technologies to where they are needed.
- **Build human capital:** strengthen people's skills by focusing on both cognitive and collaborative skills in education systems, and develop and leverage management skills and greater investment in lifelong learning.
- **Pursue growth industries:** ensure investment conditions are right for export-facing growth industries that draw on Australia's current natural and human capital strengths and build competitive advantage in global markets and value chains.

FIGURE 16: TOTAL FACTOR PRODUCTIVITY (TFP) ANNUAL GROWTH RATES IN AUSTRALIA



This figure shows historic productivity growth rates in Australia, based on Australian Bureau of Statistics (ABS) data, followed by the modelled projections, comparing the *Slow Decline* and *Outlook Vision* scenarios. Historic TFP is calculated as the (Solow) residual productivity after accounting for capital (K), labour (L), energy (E), materials (M) and services (S). This method of calculating TFP is based on national accounts and is broadly comparable to the TFP values generated by the CSIRO modelling (see the *Australian National Outlook 2019: Technical report*[12]).

4.1.1 ADOPT TECHNOLOGY

Over the past three decades, Australia's annual increase in Total Factor Productivity (TFP) has ranged widely, averaging 0.6% (Figure 16). In the *Outlook Vision*, Australia's economy-wide TFP would rise steadily to almost 2% in 2060, compared with being stuck below 1% under *Slow Decline*. That performance in TFP under the *Outlook Vision* accounts for over half the 36% increase in GDP per capita compared with *Slow Decline* (Figure 11). It also brings Australia closer to the current productivity frontier (the maximum or theoretical productivity achievable), relying on Australia's traditional strengths and creating new ones through the adoption globally competitive technology and expertise.

There is no doubt that the *Outlook Vision* presents an extremely high bar for future productivity growth. There are also diverging opinions as to whether and how it may best be met, but other countries, such as Sweden, have experienced such lifts (see Box 2) and it is well within Australia's historical range. Australia achieved consistently high productivity growth through the 1980s and 1990s driven by a suite of economic reforms that targeted competition.[49,50] Furthermore, the digital economy may offer further productivity gains above historical levels because it is still believed to be in an 'installation phase', where technologies are just emerging and are localised to certain industries and companies. Productivity gains may not become visible until the 'deployment phase', where widespread adoption enables the full potential of the digital economy to be realised.[51]

If this productivity level is to be met, it will depend in large part on the adoption of technology. 'Technology' means all technology (new and old, as well as digital, mechanical and human processes), not just digital. The rate of broad technology adoption is the most important differentiator between national economic performances,[52] and has been shown to account for at least one-quarter of real per capita income growth.[53]

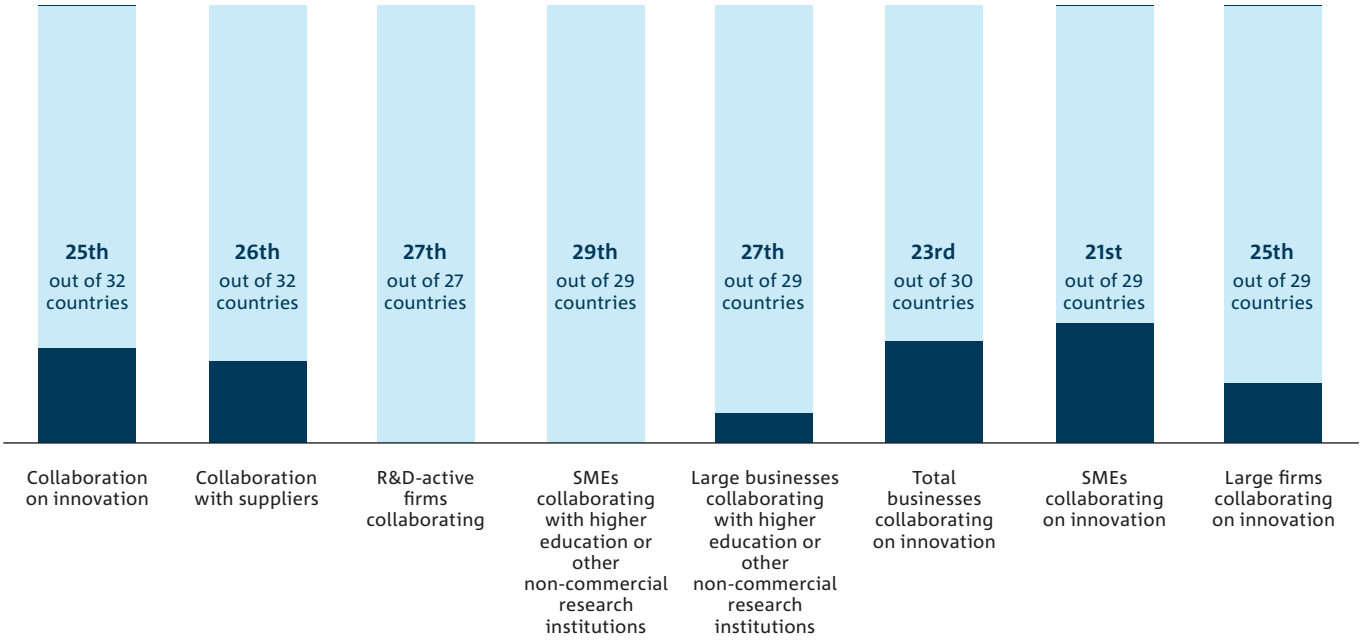
49 Australian Treasury (2009) Raising the level of productivity growth in the Australian economy. Australian Government
50 Banks G (2005) Structural reform Australian-style: lessons for others? Available at https://www.oecd.org/australia/39218531.pdf
51 van Ark B (2016) The productivity paradox of the new digital economy. International Productivity Monitor
52 Gancia G, Zilibotti F (2009) Technological change and the wealth of nations. Annual Review of Economics 1, 93–120
53 Comin D, Hobijn B (2010) An exploration of technology diffusion. American Economic Review 100, 2031–59

The complexity and the rapid rate of technological change means that collaboration is key to supporting technology adoption and how it spreads in businesses and industries. For example, participation in global value chains and collaboration across sectors, as well as with research organisations, have been found to promote learning from global and national frontier industries and organisations, providing businesses with critical exposure to new technologies and skills.

Many measures suggest that Australia's collaboration performance is low. Australia ranks the lowest in global value chains participation of any developed nation[54] and in the bottom half of most national OECD metrics on collaboration (Figure 17). This may explain some existing gaps in technology adoption. For example, only half as many firms in Australia are currently adopting automation technologies compared with the leading countries.[55] This gap may widen if the global rate of technology adoption rises[53] and Australia continues to lag in collaboration.

Organisations can play a leadership role in technology adoption by sharing lessons and strategies with smaller firms and start-ups to help them support, develop and transition employees during periods of technological change and disruption (see Box 4). For example, a survey of large multinational companies showed that many are investing in reskilling of employees, improvements in job rotation and mobility, collaboration with educational institutions, new apprenticeships and targeting female and minority talents.[56]

FIGURE 17: AUSTRALIA'S COLLABORATION RANKINGS AGAINST THE OECD[57]



This figure shows Australia's relative position compared to a selection of countries on a range of innovation collaboration measures. The sample includes all 35 member countries of the OECD, as well as China, Taiwan and Singapore where data are available (SMEs refers to subject matter experts).

54 Department of Industry, Innovation and Science, Office of the Chief Economist (2018) Industry insights: globalising Australia. Australian Government

55 AlphaBeta (2015) The automation advantage. AlphaBeta

56 World Economic Forum (WEF) (2016) The future of jobs: employment, skills and workforce strategy for the Fourth Industrial Revolution. WEF

57 Department of Industry, Innovation and Science, Office of the Chief Economist (2017) Australian innovation system report 2017. Australian Government

BOX 2: Sweden joins the productivity frontier

Sweden's transition to the frontier provides an interesting study for potential productivity growth. Results from the OECD Productivity Statistics Database suggest that Sweden was one of the few nations in the early 2000s to experience a lift in TFP growth and to move into the productivity frontier.[58] Although this uplift has not been sustained and reflects, in part, Sweden's recovery and technological 'catch-up' from the deep recession of the early 1990s, studies have also attributed some of the uplift in productivity and innovation in the 2000s to the following:[59,60,61]

- **Greater skilling of labour** through a world-class education system, modernisation of wage and industrial agreements and innovative workplace practices to produce and incentivise a productive workforce.
- **Increased deregulation and competition** across sectors, attributed, in part, to new competition laws, various economic reforms, entrance into the European Union and establishment of the World Trade Organization, to promote innovation and productivity.
- **Attraction of large multinational corporations**, with many on the global and/or technology frontier. These companies were also early to capitalise on emerging global demand, use and demand skilled labour, employ modern workplace practices, invest significantly in research and development (R&D) and benefit from professional leadership.

Much of this uplift in productivity was concentrated in Sweden's manufacturing, financial services and commodities industries, as well as wholesale and retail trade, and was attributed to relatively strong productivity growth and efficiency improvements during this period.[47,62] Table 1 outlines factors contributing to the uplift in TFP observed for these sectors.

TABLE 1: FACTORS CONTRIBUTING TO THE UPLIFT IN TOTAL FACTOR PRODUCTIVITY IN DIFFERENT SECTORS IN SWEDEN

Manufacturing, financial and business services and commodities	• The Agreement on Industrial Development and Wage Formation (1997) encouraged good labour market relationships, company competitiveness and investment in staff development. • Relatively high investment in R&D as a proportion of GDP from 1993 to 2000 (~3.4% vs ~1.5% in Australia and ~2.5% in the US).[63] • Stronger business 'fundamentals', as measured by education attainment levels and quality of management processes, relative to other OECD countries. • Quicker adaptation and streamlining of production processes and improved infrastructure (e.g. transport) to capture emerging global demand relative to competitors.
Wholesale and retail trade	• Arrival of relatively more productive 'superstores' and specialist chains. • Technological advances in logistics. • Planning and Building Act amendment in 1993 that postured municipalities to favour competition over protectionism.

58 OECD (2018) Annual growth in total factor productivity. OECD Productivity Statistics Database

59 Nauclér T, Tyreman M, Roxburgh C (2012) Growth and renewal in the Swedish economy. McKinsey Global Institute

60 Schön L. Sweden – economic growth and structural change, 1800–2000. Available at https://eh.net/encyclopedia/sweden-economic-growth-and-structural-change-1800-2000/

61 Remes J, Manyika J, Bughin J, Woetzel J, Mischke J, Krishnan M (2018) Solving the productivity puzzle: the role of demand and the promise of digitisation. McKinsey & Company

62 EU KLEMS Database (2017) Total Factor Productivity (value added per hour worked based) Growth, EU KLEMS Growth and Productivity Accounts: Statistical Module, ESA 2010 and ISIC Rev. 4 industry classification

63 OECD iLibrary (2012) R&D investment statistics. Average R&D spend as a percentage of total GDP between 1993 and 2000. OECD

4.1.2 BUILD HUMAN CAPITAL

Human capital and how effectively people can work (or couple) with technology is an important driver of productivity and is responsible for nearly 20% of the GDP growth experienced under the *Outlook Vision* scenario (Figure 11). How human capital can be improved is complex. It relates to factors including education, STEM skill cultivation, vocational training, policy, workforce mobility and management. This report has focused on management performance to maximise outcomes today as one element that we can leverage.

Cognitive and creative skills

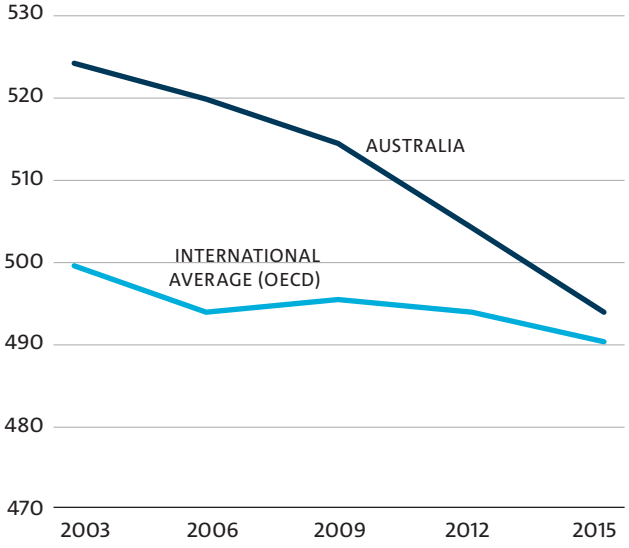
The pace of technological change requires skills development for future generations. Cognitive skills, which help people couple with technology, as well as strong creative, social and translational skills will take on new importance. These skills are difficult to displace by technology and carry the co-benefit of promoting greater social opportunity and cohesion.[64] Although Australia currently performs well in areas like collaborative problem solving, the most recent OECD Programme for International Student Assessment (PISA) results highlight a steady decline in areas such as mathematics and science.[9,65] Addressing these declines are important because small improvements in workforce cognitive skills can have very large effects on GDP and future well-being.[66]

Australia's performance in mathematics provides a useful example of the challenges ahead, because mathematics has been found to be a good proxy for the types of skills needed to develop, adopt and work with technology. This includes the ability to recognise and apply logical relationships among data and concepts to create or test a new insight.[9] In mathematics, and to a lesser extent in science, Australian student performance is declining (Figure 18). In a related indicator, the Global Innovation Index, Australia in 2018 was ranked 69th out of 104 countries in the total percentage of tertiary graduates in science and engineering.[67] Furthermore, there is a clear and widening gap in educational outcomes, with the rate of decline in educational performance among Australia's bottom-performing students falling faster than those at the top, exacerbating inequality.[68]

FIGURE 18: AUSTRALIAN PROGRAMME FOR INTERNATIONAL STUDENT ASSESSMENT (PISA) MATHEMATICS RANKINGS

NATIONAL OUTCOMES IN MATHEMATICS

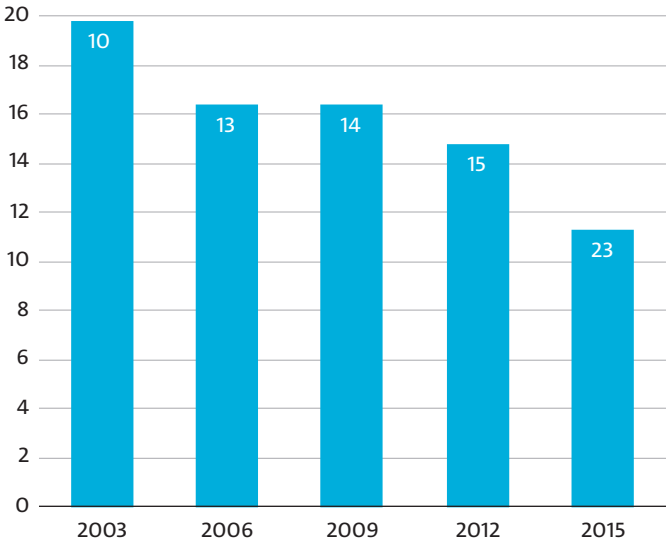
PISA MATHEMATICS SCORES



Source: OECD, PISA Scores

TOP PISA MATH PERFORMERS IN AUSTRALIA

AUSTRALIAN MATH PERFORMERS IN TOP 10%, WITH GLOBAL RANK (%)



Source: PISA 2015

These figures show Australia's PISA scores in mathematics. The figure on the left compares Australia's scores against the OECD average. It shows that in 2003 Australia's PISA scores used to be 25 points ahead of the OECD average; in the latest results, Australia was just 5 points ahead. The figure on the right shows a decline in the percentage of Australian students in the top 10%, with the associated global ranking in white.

64 Department of Education and Training (2018) Through growth to achievement: report of the review to achieve educational excellence in Australian schools. Australian Government

65 OECD 2015 PISA Results; National Centre for Education Statistics International Data Explorer.

66 Hanushek EA, Woessmann L (2010). The high cost of low educational performance: the long-run economic impact of improving PISA outcomes. OECD

67 Cornell University, INSEAD, WIPO (2018) Global Innovation Index 2018: energizing the world with innovation. WIPO

68 Hetherington D (2018) What price the gap? Education and inequality in Australia. Public Education Foundation

Mathematics and other STEM (science, technology, engineering and mathematics) skills are necessary, but very few professionals can rely on those alone. Technology and artificial intelligence are not expected to replace human skills such as creativity and collaboration. Therefore, these skills should be continually developed across the workforce and combined with technical subject matter. High Tech High in California provides an effective model of how to integrate STEM and collaborative learning, with students working on technology projects alongside peers and local businesses. The success of this model is exhibited by its ranking in the top 10% of schools in the state of California and by the reports that 98% of their students go on to college. In addition, 65% of its graduates entering college are the first to do so in their family, demonstrating a successful integration of differing socioeconomic statuses.[69]

However, learning does not stop at high school and, instead, is now considered to be lifelong. People can expect portfolio careers, potentially having 17 jobs and five careers in their lifetime,[70] perhaps in industries that do not yet exist. This means that workers will need the cognitive tools and confidence to navigate these changes. To set the foundations for lifelong learning, investments in early childhood education (0–4 years) will help build resilience and adaptability, and the cognitive and collaborative skills needed throughout the formal education years.[71] Post-school generations, even those with strong academic records, will need to maintain and update these learning skills throughout their working lives.

Fostering these new types of skills and attitudes towards learning will not be easy for all (see Box 3). However, governments and industry can facilitate opportunities for mature-age learning and take greater responsibility for forced transitions by providing support services.[72] Increased demand for relearning and further learning will encourage education providers to respond with industry-relevant courses. Over time, it is important to help people with employment transitions, making it an opportunity, rather than a disruption.

BOX 3: Effect of socioeconomic disadvantage on human capital

To nurture new skills and positive attitudes towards learning, current and new educational approaches must be socially inclusive and compensate for the effects of the social gradient. The 'social gradient' refers to the phenomenon whereby, for the population as a whole, the lower an individual's socioeconomic position, the worse their expected health, education and economic participation. Those further down the socioeconomic scale tend to experience poorer educational opportunities, exacerbated by their tendency to attend fewer hours of early childhood education and to have poorer school attendance records. More disadvantaged individuals are less likely to be school ready and are more likely to fall increasingly behind their peers over the course of their primary and high school years. Aboriginal and Torres Strait Islander students are significantly less likely to benefit from the Australian school system due to their overrepresentation among the most highly socioeconomically disadvantaged.[73]

Decreasing inequity and actively countering the effects of the social gradient in health and education are key to opening up opportunity for all and achieving strong growth in human capital. Success in these areas will be seen in the weakening and eventual breakdown of the association between the degree of disadvantage and the extent of overrepresentation in the cohort experiencing the poorest health, life expectancy, educational achievement and economic participation.

69 Jobs for NSW (2016) Jobs for the future: Adding 1 million rewarding jobs in NSW by 2036. NSW Government

70 Foundation for Young Australians (FYA), AlphaBeta (2017) The new work smarts: thriving in the new work order. FYA

71 Australian Government (2018) Through Growth to Achievement: Report of the Review to Achieve Educational Excellence in Australian Schools

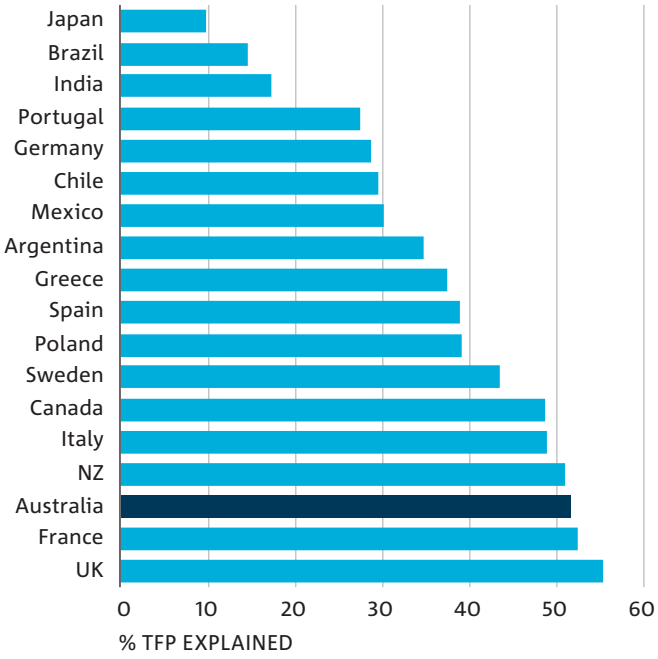
72 PwC (2017) Career and skills pathways: research into a whole-of-system approach to enhancing lifelong career support mechanisms for all Australians. Australian Government

73 Lamb S, Jackson J, Walstab A, Huo S (2015) Educational opportunity in Australia 2015: who succeeds and who misses out. Mitchell Institute

Management performance

Australia has an opportunity to draw on global insights in relation to management as a lever to increase productivity. When compared internationally, for example, approximately 50% of the productivity gap between Australia and the US is explained by management scores (Figure 19).[74] In addition to improving productivity, addressing this issue could benefit an improvement in inclusiveness and reduce unemployment.[75]

FIGURE 19: DIFFERENCE IN THE TOTAL FACTOR PRODUCTIVITY (TFP) GAP COMPARED WITH THE US EXPLAINED BY MANAGEMENT SCORES[74]



This figure shows how much of Australia's productivity gap with the US is explained by management performance. This indicates that improvements in management capability offer a substantial opportunity to improve productivity compared to countries like Japan. Many firms are well below the management performance frontier (Pooled data from 2004 to 2014).

Two areas that could offer considerable returns include how skills are allocated and people management. Compared with international peers, Australia is quite inefficient in its level of over- and under-skilled workers (Figure 20), an area that may translate into an estimated direct productivity loss of over 6%.[75,76] Australia also ranks poorly in people management. A dimension of this metric is 'instilling a talent mindset'. This refers to senior manager abilities in 'attracting, developing and retaining talent, and identifying innovative but practical ways of developing human capital', an area in which Australia's scores are especially weak.[77] There are considerable benefits to be gained from improving management scores: a single-point improvement (measured on a five-point scale) is associated with an increase in output equivalent to a 56% increase in the labour force or a 44% increase in invested capital.[77]

Improvements are to be gained in management practices through strong competition and flexible labour markets.[78] At an organisational level, being publicly listed or being exposed to international markets through supply chains or export can also have beneficial effects on performance.[78]

4.1.3 PURSUE GROWTH INDUSTRIES

The *Outlook Vision* assumes that Australia continues to nurture its traditional industries which have supported the nation's growth for so long, but also creates new forms of competitive advantage. This is spurred on by improvements in attracting investment and a collaborative, world-leading education system. It also assumes that Australia has a competitive regulatory environment, one that promotes innovation, has the right policies to sustain productivity growth,[75] and one that considers innovation systems rather than just addressing market failure.[79]

These advantages create the right conditions for innovation and investment in the *Outlook Vision*, contributing approximately 20% additional per capita GDP compared with the *Slow Decline* scenario (Figure 11).

74 Productivity Commission (2017) Productivity and income – the Australian story. Shifting the dial: 5 year productivity review, Supporting Paper No. 1. Australian Government

75 OECD (2015) Future of productivity. OECD

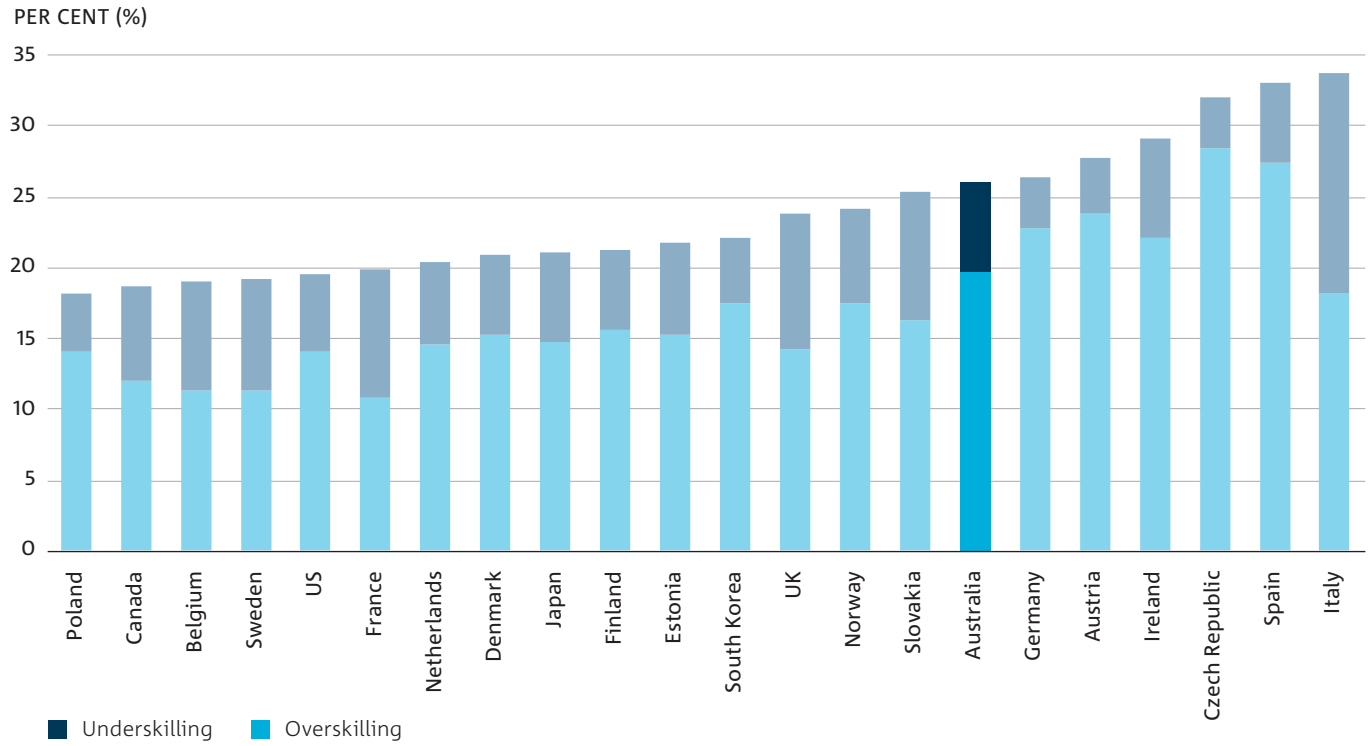
76 Note: Although the OECD Future of Productivity report65 has estimated productivity loss for Australia, the OECD advises interpreting the figure with caution due to insufficient productivity data

77 Green R, Agarwal R (2009) Management matters in Australia: just how productive are we? Findings from the Australian Management Practices and Productivity Global Benchmarking project. Department of Innovation, Industry, Science and Research

78 Bloom N, Dorgan S, Dowdy J, Van Reenen J (2007) Management practice and productivity: why they matter. McKinsey & Company

79 Dodgson M, Hughes A, Foster J, Metcalfe S (2011) Systems thinking, market failure, and the development of innovation policy: the case of Australia. Research Policy 40, 1145–56

FIGURE 20: COMPONENTS OF SKILL MISMATCH: SELECTED OECD COUNTRIES, 2011–12[74]



This figure shows the levels at which workers in selected OECD countries have mismatched skills. Under- and over-skilled workers are defined as the percentage of workers whose scores are higher than that of the minimum and maximum skills, respectively, required to satisfy standard job-level requirements (defined as the 10th and 90th percentiles, respectively, of scores of the well-matched workers in each occupation and country). To account for cross-country sectoral composition differences, the one-digit industry level mismatch indicators are aggregated using industry employment weights for the US.

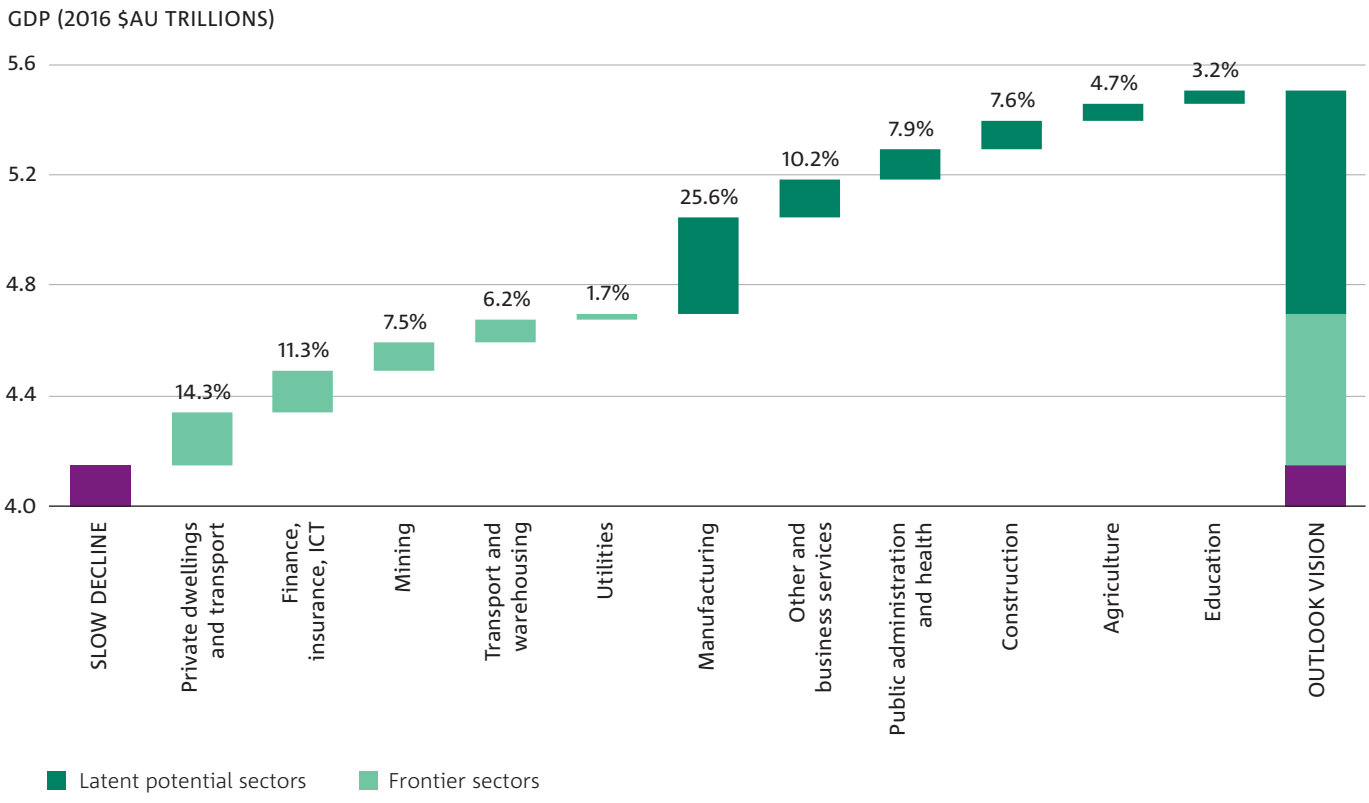
They also support new technology-enabled growth industries and business models, such as the value-adding and diversification opportunities that exist at the intersection of traditional sectors like manufacturing and services.[54,80] As an example, there are opportunities for medical device companies to manufacture customised bionics and, in addition, offer related bundled services that improve patient outcomes and further refine device performance.[81]

Under the *Outlook Vision* these conditions in particular support latent potential sectors that are ripe for technology investment and TFP improvements, helping them move towards the global productivity frontier. Because some of these latent potential sectors are a considerable distance from that frontier, this move contributes 59% of the GDP difference (Figure 21).

80 Visnjic I, Van Looy B (2012) Servitization: Disentangling the Impact of Service Business Model Innovation on Manufacturing Firm Performance. Journal of Operations Management 31(4): 169–180

81 CSIRO Futures (2017) Medical Technologies and Pharmaceuticals: A Roadmap for unlocking future growth opportunities for Australia. CSIRO

FIGURE 21: GDP CONTRIBUTION PER SECTOR



This figure shows the computed sector contribution to GDP differences between *Slow Decline* and the *Outlook Vision* (under a cooperative global context). Frontier sectors are those that are currently achieving a globally competitive productivity rate, whereas those labelled as latent potential sectors are currently lagging behind. This means that latent potential sectors growing faster than the *Slow Decline* GDP growth rate will contribute relatively more to the higher *Outlook Vision* (under a cooperative global context) GDP level.

BOX 4: An extreme possibility – *Jobless Growth*

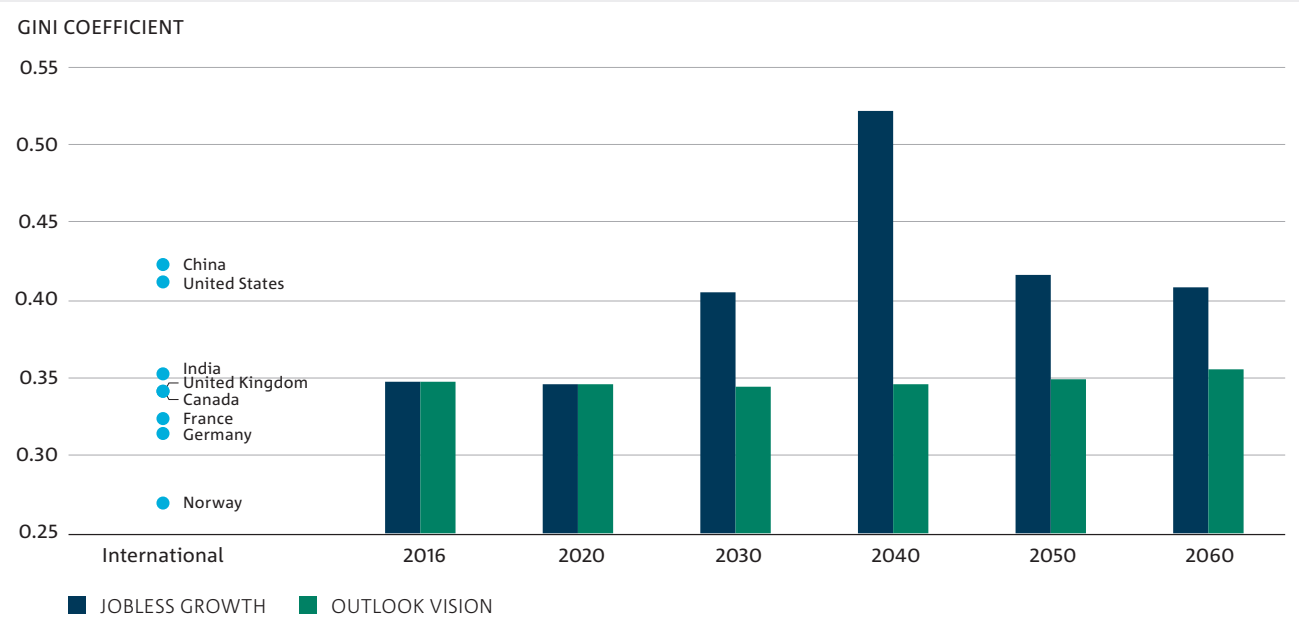
Historically, technological change has been a net creator of jobs. However, the effects of technological change are hard to predict due to the nature, speed of adoption and scale of the changes. Expert opinion and research vary markedly, with predictions ranging from reasonably positive outcomes to a damaging loss of jobs.

It is therefore worth considering what may happen if Australian firms do broaden and deepen their technology base, but human capital lags. In this more unlikely case, termed *Jobless Growth*, modelling suggests that technology can significantly disrupt employment for a relatively large proportion of the population, even as per capita GDP rises. Therefore, this result suggests that building relevant skills throughout the population is paramount for Australia.

The most recognisable marker of this extreme scenario is that the labour market splits into those who have the skills to work with new technologies and those who do not. For those who do have the skills, wages initially grow faster than in other scenarios as firms compete for a small pool of skilled labour. However, a generation of workers unprepared for such a significant technological shock could suffer. Unemployment could peak at nearly 20% in 2040, which is in line with some of the higher job loss predictions available. Only eventually do wages begin to converge as a new generation of workers enters the workforce with more productive skills, returning Australia to a path of higher economic growth, but with unemployment at a new equilibrium of approximately 10%.

The broader social consequences in this scenario may be worse than the economic consequences. Although unemployment levels are extreme, the economy as a whole is still faring reasonably well (average annual growth is 2.4%, compared with 2.8% in *Outlook Vision*) and, indeed, those who are employed are doing well. However, this means that income inequality could be far worse than ever experienced in Australia (Figure 22), with potential broader negative effects on health and education[82] outcomes, as well as an increased risk of economic instability.[83]

FIGURE 22: INCOME INEQUALITY



This figure shows modelled Gini coefficient projections for the *Outlook Vision* and the more extreme *Jobless Growth* scenario to 2060, compared with the present-day income inequality of selected countries. A distribution's deviation from absolute equality can be summarised by a Gini coefficient, which takes a value of 0 if the distribution exhibits perfect equality and a value of 1 with absolute inequality (e.g. one individual captures all income). Although the income Gini coefficients for both the *Slow Decline* and *Outlook Vision* scenarios hover around 0.35, the unemployment modelled in the *Jobless Growth* scenario generates a significant increase in income inequality and the associated Gini coefficient. Note that the modelled income Gini coefficients are based on a pre-tax, pre-government transfer income distribution.

82 Karlsson M, Nilsson T, Lyttkens C, Leeson G (2010) Income inequality and health: importance of a cross-country perspective. Social Science & Medicine 70, 875–85

83 Kumhof M, Ranciere R, Winant P (2015) Inequality, leverage, and crises. American Economic Review 105, 1217–45

As to where this growth specifically comes from, this report shares the long-held view about exercising caution with regard to 'picking winners'. Nonetheless, a selection of growth opportunity examples has been identified to highlight the potential. These examples are by no means exhaustive, and simply aim to spur discussion.

Healthcare[84]

As the population ages, Australia's healthcare industry strengths can be leveraged to develop technologies and services that precisely anticipate and prevent diseases, help people manage their health and well-being throughout the course of their life and ease the burden of financing health care. Example opportunities include:

- Predictive data platforms and analytics that combine medical data with information around diet, activity levels and one's physical and social environment.
- Precision interventions that draw on novel and tailored diets and lifestyle strategies.

Cyber security[85]

Australia's cyber security industry can act as a key growth-enabling activity to help businesses secure, build trust in and differentiate their digital offerings internationally. Example opportunities include:

- Australian manufacturers developing customised solutions require access to client data, including personal information or intellectual property; cyber security solutions are needed to improve channels for secure sharing of data.
- Data-driven decisions affect the physical operations of mine sites through Australian-developed technology; cyber security solutions need to ensure operational technology is secured against malicious attack to improve physical safety on a mine site.

Mining[86]

The majority of near-surface, high-quality mineral deposits have already been identified and developed, requiring new equipment and services for explorers in Australia and overseas to identify new reserves deeper under cover. Example opportunities include:

- Advanced sensing technologies and more durable and faster drilling equipment to better detect and characterise minerals under cover.
- New targeting and decision support platforms to provide insights into how to predict, navigate and detect resources in the subsurface prior to drilling.

Metals[87]

With a growing need for energy storage, Australia has the skills and resources to develop a consolidated local battery value chain. Example opportunities include:

- Mining of raw materials and processing into higher-grade metals, such as lithium, nickel and zinc, all the way through to cell or battery pack design and assembly.
- Creating a battery recycling industry because of the uncertainty over the extent of reserves of relevant metals.

Food manufacturing[88]

The rising Asian middle class is creating opportunities for Australian food manufacturers to create premium offerings. Example opportunities include:

- In agriculture, using biosensors and blockchain to create a time-stamped ledger of a food's journey from paddock to plate, playing a major role in the safety, biosecurity, duty payments and traceability of branded food.
- Using advanced nutrient extraction and food lifetime extension technologies to complement the agriculture sector's need to get more out of the foods farmed and produced.

84 CSIRO Futures (2018) Future of Health. CSIRO
85 CSIRO Futures (2018) Cyber security roadmap. CSIRO
86 CSIRO Futures (2017) Mining equipment, technology and services: a roadmap for unlocking future growth opportunities for Australia. CSIRO
87 Campey T, Bruce S, Yankos T, Hayward J, Graham P, Reedman L, Deverell J (2017) Low emissions technology roadmap: technical report. CSIRO
88 CSIRO Futures (2017) Food and agribusiness: a roadmap for unlocking future growth opportunities for Australia. CSIRO

Agriculture[88]

The world's population and its demand for food are growing fast, but the world's arable land is not. More efficient and advanced agricultural techniques are required to get the most out of the world's land resources. Example opportunities include:

- Genomic technologies that can help develop crops resistant to root diseases and tolerant to subsoil constraints, drought conditions, frost and high temperatures.
- Precision farming and water resource management enabled by high-performance Earth observation data analytics and space-enabled ground sensor networks to help relieve drought pressure while increasing agricultural yield.

Hydrogen[89]

As the world transitions to a low-carbon economy, demand for Australia's traditional energy exports, like thermal coal, are predicted to decline. Australia's extensive natural resources, namely solar, wind, fossil fuels and available land, lend favourably to the establishment of hydrogen supply chains. Example opportunities include:

- Export of low emission hydrogen.
- Hydrogen for energy storage.
- Development and manufacture of hydrogen technologies, like electrolysers and fuel cells, enabled by the adoption of automation.

Construction[90]

With construction representing a significant contribution to GDP, Australia needs to embrace new technologies and is well-placed to contribute to the development of these. Example opportunities include:

- Digital technology: uptake and development of virtual design tools, such as Internet of things (IoT) and analytics for project tracking, asset management, supply chain elements and staffing productivities.
- Materials technology: advancing concrete and steel construction, developing lighter and more flexible materials and developing alternative materials (e.g. developing new plastics to replace current building materials that are lighter, stronger and more ecofriendly).
- Construction automation technology: additive construction or 3D printing of modules for construction, autonomous technologies for machinery, drone technology for surveying and using robotics for repetitive tasks like bricklaying and concrete paving.

Education[91]

Education is changing rapidly and has become Australia's third largest export.[92] New technologies must be embraced to continue this growth and for Australia to remain relevant in a global context.

- Changes to how people interact with computers and the adoption of machine learning, big data, augmented reality and digital and online learning platforms stands to upend the education experience, and the production of the associated software presents an opportunity for Australian developers.

89 Bruce S, Temminghoff M, Hayward J, Schmidt E, Munnings C, Palfreyman D, Hartley P (2018) National hydrogen roadmap. CSIRO

90 Barbosa F, Woetzel J, Mischke J, Ribeirinho MJ, Sridhar M, Parsons M, Bertram N, Brown S (2017) Reinventing construction: a route to higher productivity. McKinsey Global Institute

91 Centre for Digital Technology & Management (CDTM) (2015) The future of education trend report 2015. CDTM

92 Department of Foreign Affairs and Trade (2018) Based on ABS trade data on DFAT STARS database and ABS catalogues 5368.0 (September 2017) & 5429.0. Australian Government

4.2 Urban shift: World-class cities

In the *Outlook Vision*, Australia has well-connected, affordable capital and satellite cities that offer equal access to quality jobs, lifestyle amenities, education and health services.

SELECTED *OUTLOOK VISION* MEASURES

Average density in our major cities increases by **60–88%**.

Urban vehicle kilometres travelled per capita reduced by up to **45%**.

Planning for multiple, attractive urban centres within cities improves social outcomes.

THREE LEVERS THAT SUPPORT WORLD-CLASS CITIES INCLUDE:

- **Plan for multicentre cities:** denser capital cities grow around multiple city 'centres', creating exciting hubs that are well connected through comparably populated economic corridors.
- **Diversify housing and land use:** in both capital and satellite cities there is a greater variety of housing types located closer to jobs, services and amenities. This is not just about increasing the supply of housing, but also the supply of high-quality places to live.
- **Enhance transport infrastructure:** density and diversity enable conditions where less travel is required and better ways to make journeys, including mass-transit, autonomous vehicles and active transport, like walking and cycling, are available.

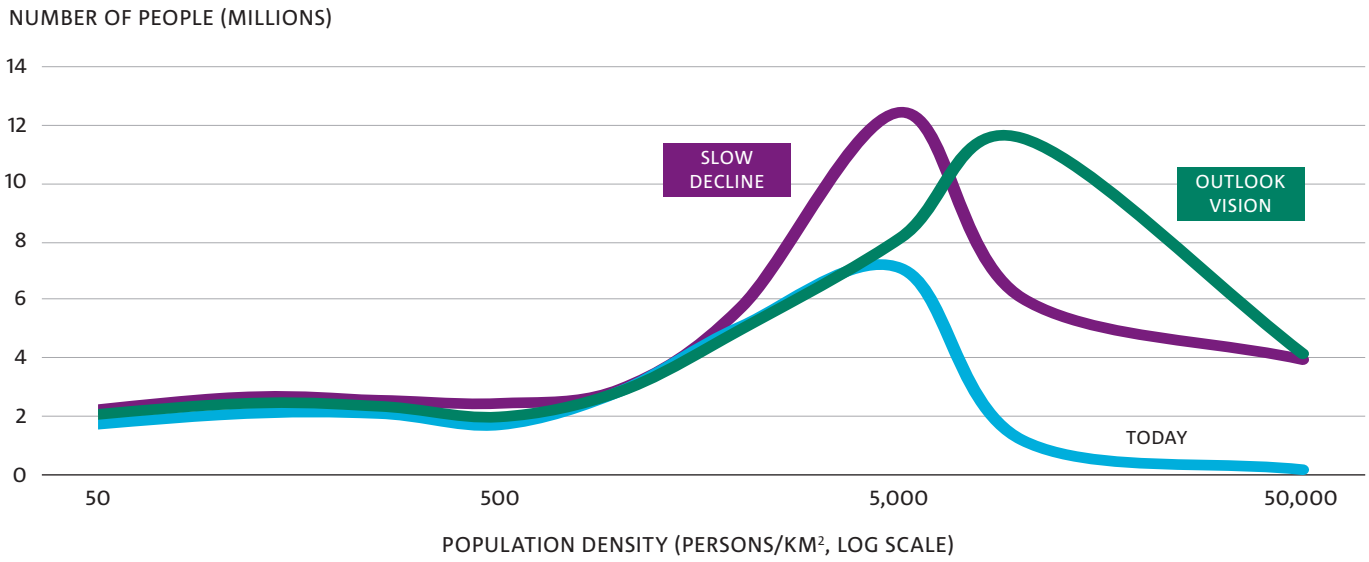
4.2.1 PLAN FOR MULTICENTRE CITIES

In both the *Outlook Vision* and *Slow Decline* scenarios, Australia's population increases to 41 million by 2060, with the four largest cities increasing their share of the population from 58% to 66% (27 million) by 2060. Achieving the *Outlook Vision* involves increasing the population density of major cities, but in well-planned and attractive ways which will require a significant change to the way planning law and policy supports city development.

The *Outlook Vision* assumes a robust program of infill concurrent with land zoning changes. This results in the average density of major cities increasing by 60–88% and assumes a greater proportion of the urban population living at higher density (not just in city centres), with multiple high-density precincts. Importantly, the *Outlook Vision* avoids the sprawl experienced under *Slow Decline*, which sees 2 million more people living in the outer suburbs (Figure 23, Figure 24).

This change is in line with the advice in *Plan Melbourne 2017–2050* to increase density within a defined urban boundary,[93] the *Perth@3.5million* strategy to absorb 47% of new growth as infill development[94] and the Sydney plan to become 'a metropolis of three cities'.[95] Currently, Australia's larger cities have approximately 1600 people per square kilometre, a low average density when compared internationally, indicating the realistic possibility of greater urban density (Figure 25).

FIGURE 23: POPULATION DENSITY OUTCOMES



This figure shows modelled population density projections of the *Slow Decline* and *Outlook Vision* scenarios compared with today's average density. *Slow Decline* sees Australia continue to have high-density populations concentrated in city centres, whereas *Outlook Vision* assumes that density is spread with a greater proportion of urban populations living at higher density. Note the logarithmic scale on the horizontal axis.

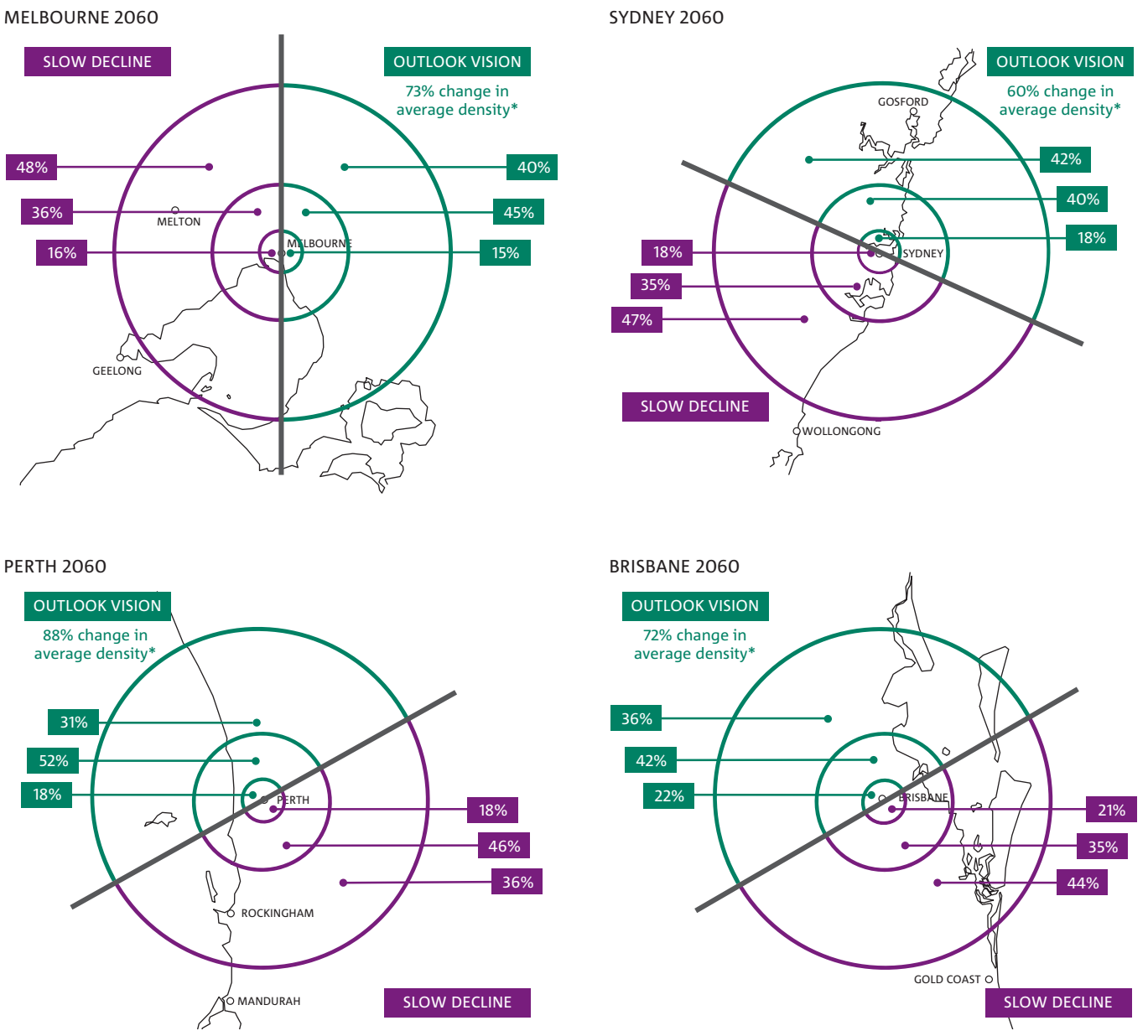
93 Victorian Department of Environment, Land, Water and Planning (2018) Plan Melbourne 2017–2050. Available at https://www.planmelbourne.vic.gov.au/

94 Western Australian Planning Commission (2018) Perth and Peel@3.5million. Available at https://www.planning.wa.gov.au/10586.aspx

95 Greater Sydney Commission (2018) A metropolis of three cities. Available at https://www.greater.sydney/metropolis-of-three-cities

However, simply increasing average urban density is not the point; rather, consideration must be given to how that density is achieved and the opportunities and lifestyles it creates. Singapore, which is often ranked as being highly liveable, provides a good example of some of these considerations through analysis of principles conducted by the Centre for Liveable Cities and Urban Land Institute.[96] The first principle that guides planning is the implementation of long-term growth strategies that are still flexible in order to adapt to change. This is closely followed by the importance of embracing diversity. By bringing diverse groups of people closer together, the analysis suggests that Singapore is better placed to utilise people's skills, knowledge and entrepreneurship. Interaction amongst the population is also believed to foster inclusiveness, building trust, cohesion and understanding. Green transport and buildings are also prioritised to provide a healthier and more energy efficient city.

FIGURE 24: FORECAST CHANGES IN POPULATION DISTRIBUTION FOR MAJOR CITIES IN 2060

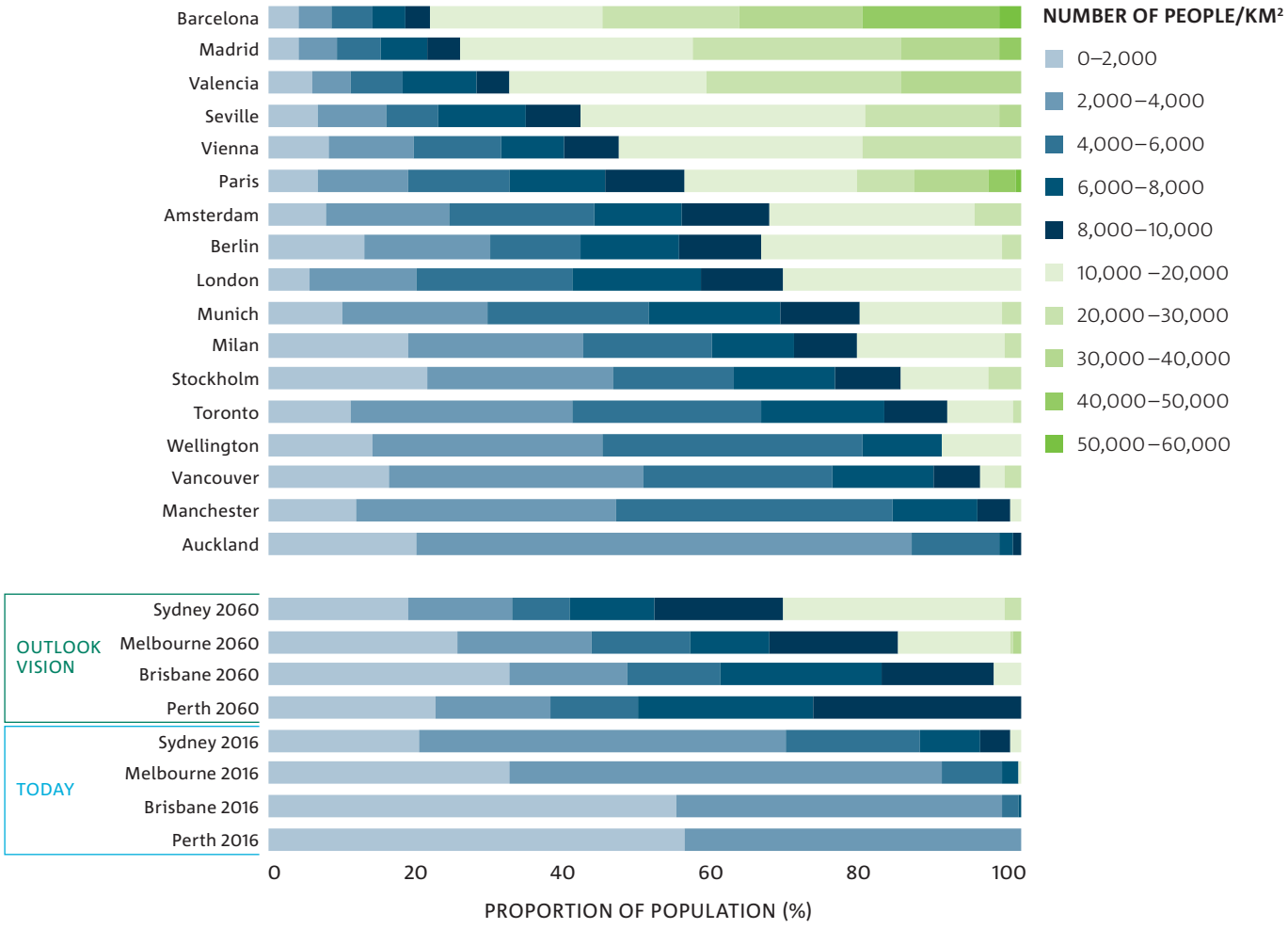


These figures show the population distributions between outer, middle and inner suburbs under *Slow Decline* and *Outlook Vision* in 2060, for Melbourne, Sydney, Perth and Brisbane. In general *Slow Decline* sees more people located in the outer suburbs, whereas under *Outlook Vision* the population is more evenly distributed. *Change in average density (2017–2060) for *Outlook Vision*.

96 Centre for Liveable Cities (CLC), Urban Land Institute (ULI) (2013) 10 Principles for Liveable High-Density Cities; Lessons from Singapore. CLC, ULI

In addition to having higher density, desirable European cities also have greater diversity of density than do Australian cities, which would be adopted under the *Outlook Vision* (Figure 25). As some international cities become large, there is evidence that suggests a single centre can become a stumbling block for better living, business and mobility; for example, Toronto has large subcentres outside of the core city, Paris and San Francisco have two established central business districts (CBDs) and London, New York and Seoul have three or more CBDs surrounded by complementary districts.[97] Importantly, larger Asian and European cities that are too big to have a single city centre also articulate their density around multiple centres, with transport routes to and between centres.[98] Australia can learn from other cities and create lifestyle choice, with quality high-, medium- and low-density areas resulting in a more variable profile in Australian cities.

FIGURE 25: PROPORTION OF THE POPULATION LIVING AT VARIOUS URBAN DENSITIES



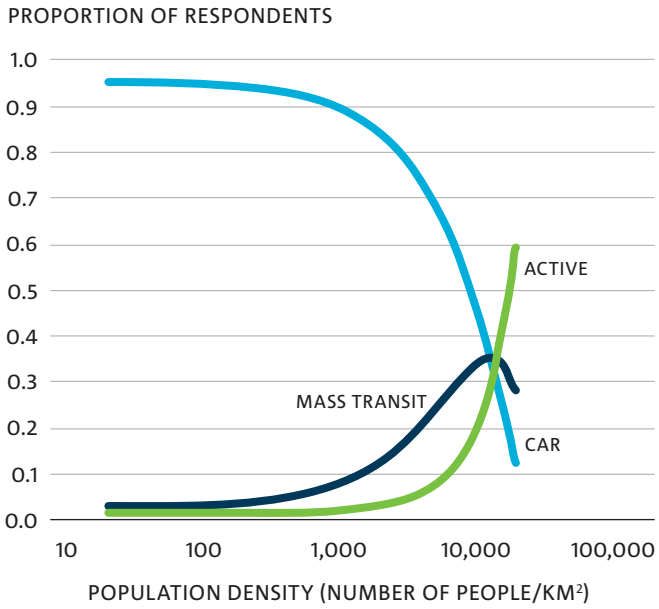
This figure shows the population densities of selected Australian cities both today and under the *Outlook Vision* scenario in 2060, and compares them alongside a selection of international cities and their densities. Data for 2010–13 were sourced from Eurostat, the ABS, Stats NZ, and Statistics Canada and processed by Chris Loader (www.chartingtransport.com). Details on 2060 density assumptions can be found in the *Australian National Outlook 2019: Technical report*.[12]

97 Clark G, Moonen T (2017) Agglomeration, centres and district plans for the Greater Sydney Commission: Lessons from international experience

98 Suzuki H, Cervero R, Iuchi K (2013) Transforming cities with transit: transit and land-use integration for sustainable urban development. The World Bank

Currently, the plan for Sydney is to add world-class high-density cities at Parramatta and a new centre further west, close to Sydney's second airport.[95] More opportunities for company location with better connectivity are attractive for local and global talent, particularly those working in the knowledge-based service industries. The increase in density also makes active and mass transit more attractive (Figure 26). Combined with more variety in the types of new housing, this presents better-quality options for downsizers, first-time home buyers and low-income groups. It also helps create more social connectedness than the periphery expansion experienced in *Slow Decline* (see Box 5). However, new urban centres and destinations need to be nurtured by sustained will from government and continuity in urban land planning strategies so that they survive the obvious initial competition from established centres. As explored in the following sections, the population change also needs to be accompanied by attractive mixes of housing, employment, amenities, green spaces and connectivity.

FIGURE 26: TRANSPORT MODE CHOICE FOR JOURNEY TO WORK



This figure shows the mode of transport Australians choose for their journey to work, mapped against the population density of their area. As density increases, so does reliance on mass transit and active transport, whereas reliance on cars decreases. Regression analysis was used on data from the ABS Census for 2016 to produce the figure.

BOX 5: Improving social performance no matter where you live

Although not modelled, the *Outlook Vision* assumes that changes in density, land use and housing are implemented in a manner that creates greater social connectedness than the periphery expansion experienced in *Slow Decline*. More specifically, it assumes that spatial polarisation issues that currently exist across inner, middle and outer suburbs are addressed, improving social outcomes no matter where you live. Conversely, *Slow Decline* assumes that existing polarisation issues are not resolved and are exacerbated as the population increases.

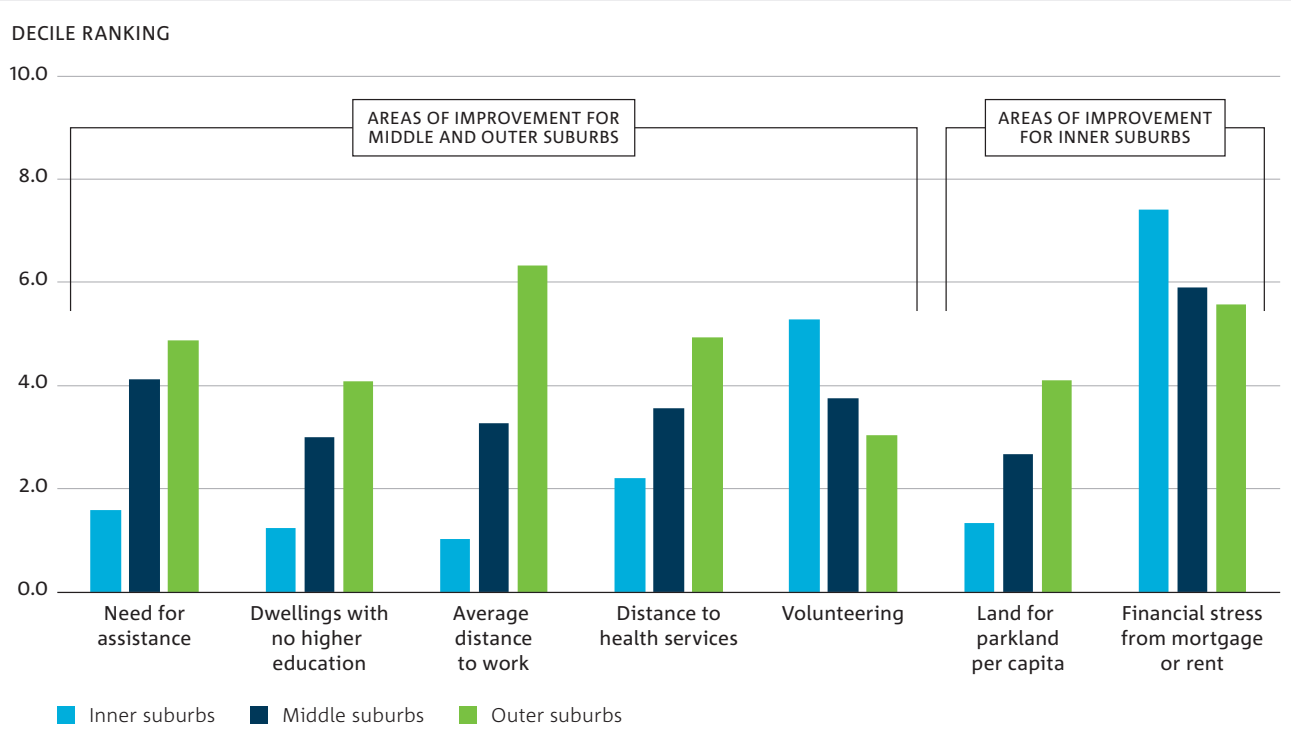
Analysis of more than 150 social measures from different databases shows a spatial polarisation of access to high-income jobs, higher education and urban amenity.

Figure 27 contains a selection of those measures and highlights opportunities for improvement across inner, middle and outer suburbs.

Those in inner suburbs fare better on many measures, with better job : person ratios, shorter distances to work and better access to health services. Continuing to grow Australia's cities at the periphery risks exacerbating polarisation. However, it is also important to consider how inner suburbs could be improved, with residents having higher financial stress and lower parkland per capita than those living in middle and outer suburbs.

By planning for multiple, attractive urban centres within cities, equalisation of these opportunities can be better pursued.

FIGURE 27: CURRENT SOCIAL OUTCOMES AND PERFORMANCE ACCORDING TO INNER, MIDDLE AND OUTER SUBURB



This figure shows the performance of different suburb zones in a range of social outcomes. For example, although inner suburbs have a shorter average distance to work and participate in volunteering more, they have less land for parkland and experience higher financial stress from housing. For definitions of inner, middle and outer suburbs and details of the databases used, see *Australian National Outlook 2019: Technical report*.[12]

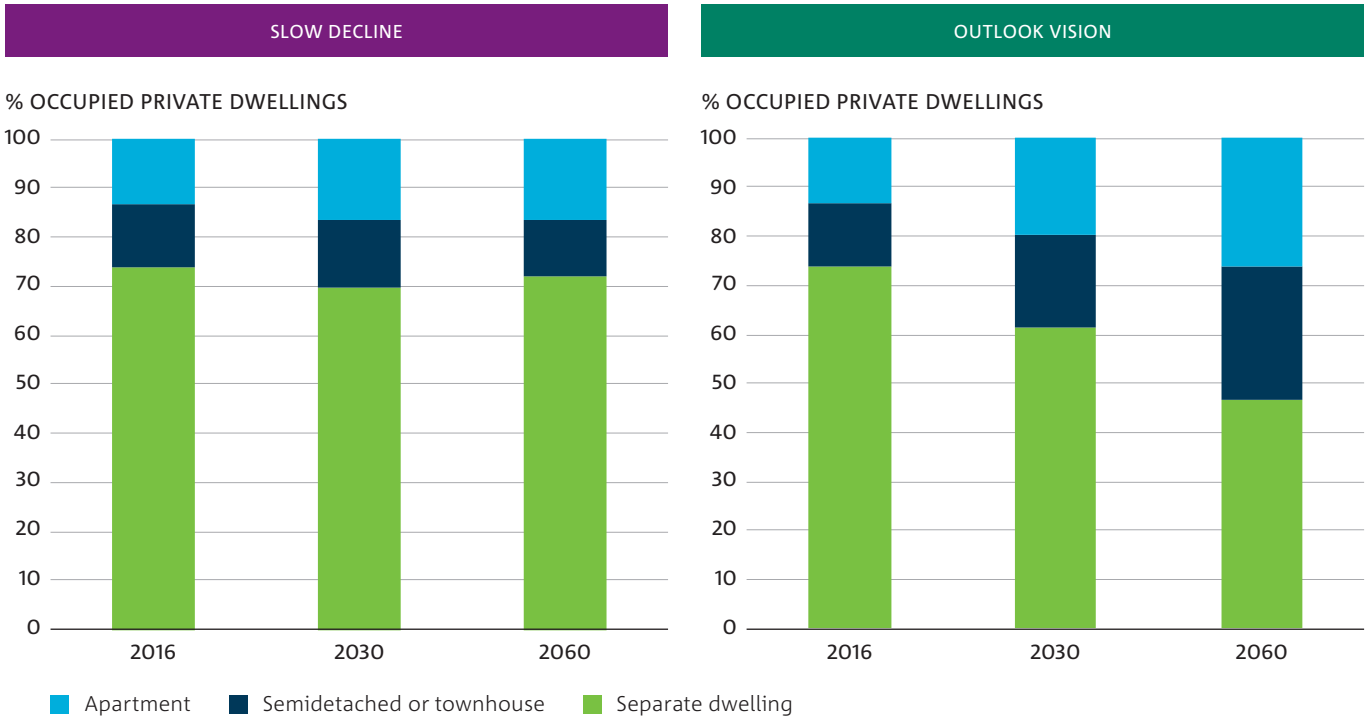
4.2.2 DIVERSIFY HOUSING AND LAND USE

In broad terms, cities are made up of housing, services, employment and green spaces. Mixing these spaces in smaller areas creates destinations in the form of diverse local precincts that provide people of different occupations and incomes better access to jobs, services and recreation. In the *Outlook Vision*, Australian cities have planned and succeeded in creating land and housing mixes that allow these diverse quality choices, allowing more people to live comfortably in cities. This has meant making good choices regarding land use, starting from today.

The land and housing mix in the *Outlook Vision* is achieved by consciously changing the housing system to one that promotes higher densities while also providing heterogeneity in the mix of housing types. The *Outlook Vision* assumes that institutional difficulties and planning restrictions are revised to allow for more mixed development and more medium- to high-rise dwelling types, mostly within the current urban area but further from the CBD. Under the *Outlook Vision*, the recent short-term trend of building new apartments in cities continues, strongly favouring medium- to high-density dwellings to the point where they become the dominant form of habitation in Australia, with well-designed apartments, semi-detached homes and townhouses making up just over 50% of the housing stock in 2060 (Figure 28). This presents quite a different suburban character to that under *Slow Decline*, which assumes that the current short-term trend away from separate dwellings in cities is transient and accommodates future density and growth on the periphery.

However, the greater mix of housing types has clear benefits. First, it allows more people to live closer to a richer set of urban jobs and amenities. Although this may not impress those who are increasingly sharing their space, for these people the benefit is the opportunity to stay within their community throughout their life stages (see Box 6). In addition, the increased mix of housing offers reasonable accommodation to the people on whom these communities rely, namely those working in essential services, education, health and personal services in particular.

FIGURE 28: HOUSING MIX BY SCENARIOS FOR CAPITAL CITIES



This figure shows the change in housing mix under the *Slow Decline* and *Outlook Vision* scenarios in 2030 and 2060, compared with 2016 housing mix data sourced from ABS Census 2016. The quantity of dwellings required, by different types, in 2030 and 2060 responds to both the demand for housing through the population projections, state-level average occupancy trends and the scenarios of change in housing mix, which are approximately a linear function of time. All figures exclude 'Other dwellings', which accounted for less than 1% in 2016.

For these developments to work well, experiences need to be learned from overseas, particularly to ensure that the higher land values created by good planning choices are translated into funds for public and community space and amenities. A good example of a direct translation of funds into amenity is Vancouver's density bonus zoning scheme.[99] This scheme allows developers more floor space than may otherwise be permitted in a zone in exchange for amenities needed by the community. Those amenities may include parks, childcare centres, affordable housing, community centres or libraries: any public asset that the local community approves.

BOX 6: Wealth lock in and lock out

'Wealth lock out' refers to people who aspire to live in higher-quality areas but cannot afford to do so because of their income or wealth in combination with the high price of housing that is closer to opportunities. 'Wealth lock in' refers to people who want to downsize in their area but can't because there aren't many options in the current dwelling stock. The attitudes of residents, and the local government they elect, also conserve urban form, leading to more wealth lock in.[4] The path of least resistance is to expand on the periphery, which only exacerbates the wealth lock out effect without providing any more options for those experiencing wealth lock in.

However, breaking the wealth lock in–lock out cycle is not easy. Convincing residents to allow changes to the use of parkland and the development of low-rise residential blocks requires a cultural shift to accept that the traditional free-standing family home (which currently accounts for over 70% of housing stock in Australia) is not the only attractive option. Urban strategists, city governments and developers must be able to offer residents more attractive options to accommodate more (and different) people closer to city centres in a successful infill strategy.

4.2.3 ENHANCE TRANSPORT INFRASTRUCTURE

Supported by better-planned cities, the *Outlook Vision* in 2060 reduces urban vehicle kilometres travelled per capita by 33–45%, compared with less than one-quarter under *Slow Decline* (see Figure 29). This could be achieved by a range of changes in the way people move around, such as more people walking, cycling or using mass transit.

Although not modelled, the *Outlook Vision* also assumes that changes in mode choices are coupled with additional improvements in areas such as:

- **Urban planning:** greater population density and multiple city 'centres' make it economically viable to drop the traditional hub-and-spoke transport model. As more transport choices and diverse travel routes criss-cross the city, '30-minute cities' can be realised, making work, shopping, socialising and services closer, increasing productivity. At the same time, car dependency will fall, and walking and cycling will be preferred options to the now-closer jobs, education and health services.
- **Mass transit:** again, population density and distribution make the difference. Rail, light rail and rail-like bus services move the most passengers per hour,[100] and their combination with autonomous vehicles is revolutionary. Autonomous vehicles provide a new low-cost, on-demand service for trips between home and more frequent mass-transit services. Automatic trains will provide safer and more punctual services, with greater energy efficiency.[101] This transition will require widespread digitisation and data integration, as well as government support.[102]
- **Data:** the capture and use of data is already changing how people use familiar services, with customers knowing when services are coming in real time, leading to increased ridership.[103] Road sensors, machine learning and analytics being used to predict and optimise the timing of traffic directions and road maintenance, as well as to inform the price and use of toll roads to move traffic away from peak times, is just around the corner.

99 City of Vancouver (2018) Density bonus zoning. Available at https://vancouver.ca/home-property-development/density-bonus-zoning.aspx

100 Kahn Ribeiro S, Figueroa MJ, Creutzig F, Dubeux C, Hupe J, Kobayashi S (2012) Chapter 9 – Energy end-use: transport. In Global Energy Assessment – Toward a Sustainable Future. Available at http://www.iiasa.ac.at/web/home/research/Flagship-Projects/Global-Energy-Assessment/Chapter9.en.html

101 NSW Government (2018) Future transport: strategy 2056. NSW Government

102 NSW Government (2016) Future transport technology roadmap 2016. NSW Government

103 Harmony XJ, Gayah VV (2017) Evaluation of real-time transit information systems: an information demand and supply approach. International Journal of Transportation Science and Technology 6, 86–98

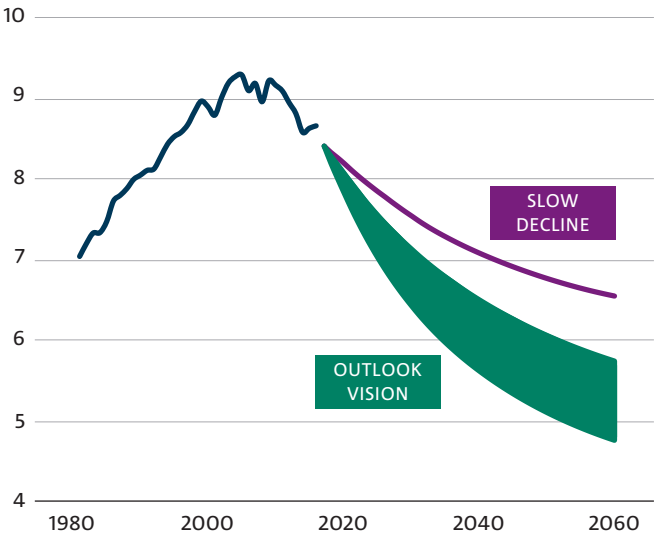
- **Autonomous vehicles and ride sharing:** based on current car usage, one shared car could do the job of 10 private vehicles.[104] Autonomous vehicles amplify the benefits. Without having to drive, people suffer less fatigue, experience fewer accidents and make more use of their transit time, which itself is reduced because autonomous vehicles move faster and with less space between them.[105] Existing lanes can manage nearly four times their current capacity,[106] reducing the need for new roads.[107] Early results suggest that driverless vehicles could increase network capacity by 42%.[108] In addition, with cars today being parked, on average, 95% of the time and parking spaces each occupying approximately 13 m^2, thousands of hectares may be reclaimed for public spaces.[109] At the same time, autonomous vehicles may create new mobility options for the young, old and those with a disability.[110]
- **Electric vehicles:** by 2060, electric vehicles make up over 80% of new vehicle sales (Figure 30). Electric vehicles running costs are 70% less per kilometre than those for a traditional vehicle.[106] The emerging competition for electric vehicles comes in the similar form of hydrogen vehicles, whose 'batteries' are also known as fuel cells. Electric vehicles have led to less noise and better air quality in urban environments,[111] as well as helping decarbonise Australia's transport sector and meet international emission targets (Figure 31).

As with housing, these improvements need to be complementary in order to achieve the transformation required. For example, the successful uptake of autonomous vehicles requires changes in density (to avoid long auto commutes or auto congestion), vehicle electrification (to avoid emissions and air quality issues) and changes in private ownership behaviours (to maximise the benefits of sharing), without which there could be no effect on the overall number of vehicles on the road, affecting congestion.[112] Costs must also be considered for a transition of this nature. Financial costs, such as investments in charging and bicycle infrastructure, as well as potential social costs, like the effects on driver occupations, need to be considered and factored into the transport transformation to ensure it is economically viable, inclusive and widely available.

Together these improvements could help address transport inequality. For example, lower-income populations tend to have worse access to transport options, coupled with lower-quality transport options and worse travelling conditions.[113] This has follow-on effects of reducing access to jobs, education, health and social networks. The successful implementation of these transport technologies, coupled with their enthusiastic adoption, can help build a supply of cheap, safe and reliable transport for people of all ages, abilities and social status, helping reduce transport inequality.

FIGURE 29: URBAN ROAD USE IN AUSTRALIA

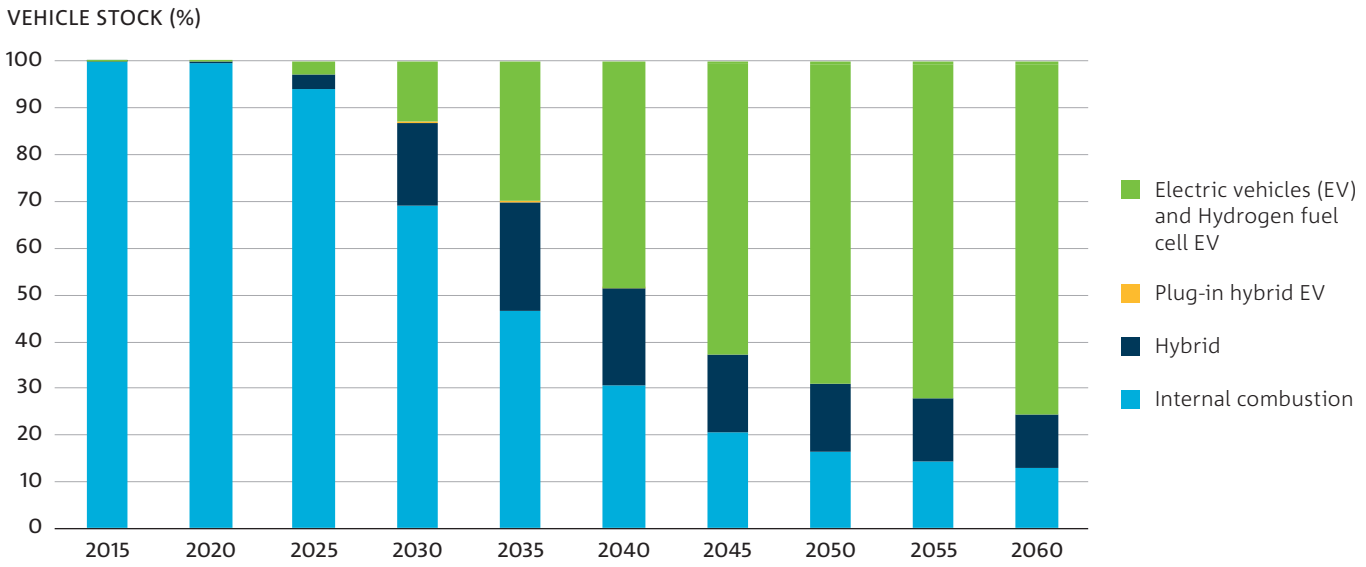
ANNUAL VEHICLE KILOMETRES TRAVELLED ('000) PER CAPITA



This figure shows the historical trend for vehicle kilometres travelled (VKT) on urban roads, per capita, followed by projections resulting from the modelled *Slow Decline* and *Outlook Vision* scenarios. The shaded area of *Outlook Vision* represents the range of outcomes possible depending on the how regional satellite cities develop (see Box 7). Data for historical VKT by road vehicles are from the Bureau of Infrastructure, Transport and Regional Economics,[114] with concurrent data on population numbers and distribution, urbanised area, income per capita and petrol prices.

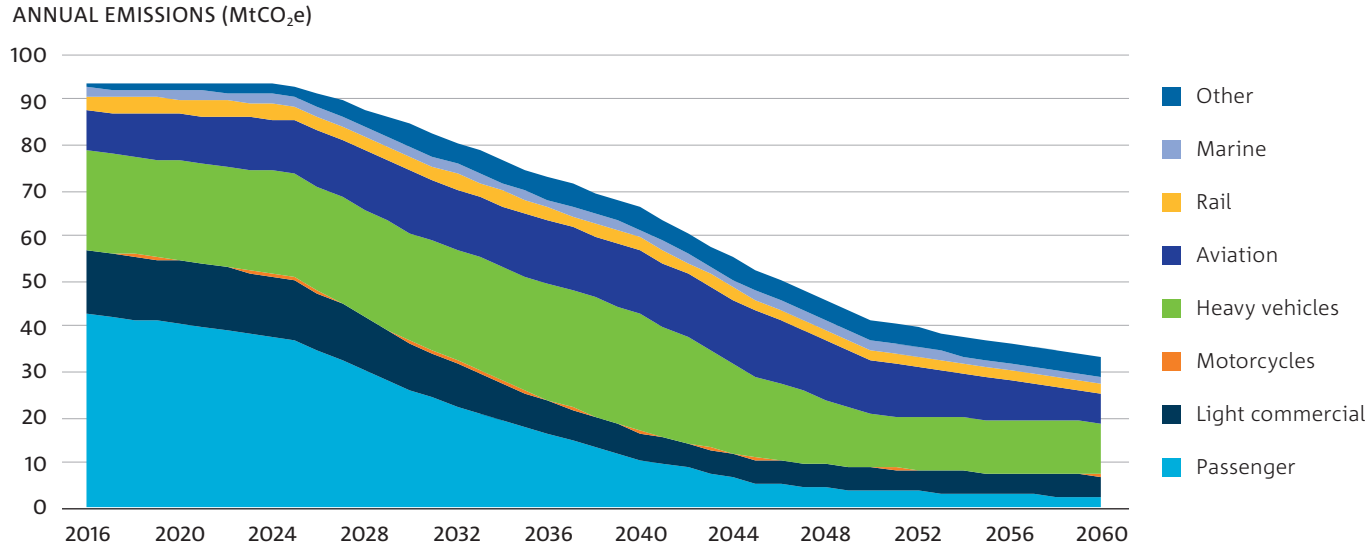
104 NRMA (2017) Future mobility series: the future of car ownership. NRMA
105 Parliament of the Commonwealth of Australia (2017) Social issues relating to land-based automated vehicles in Australia. Australian Government
106 Kane M, Whitehead J (2017) How to ride transport disruption – a sustainable framework for future urban mobility. Australian Planner 54, 177–85
107 Infrastructure Partnerships Australia (2017) Automated vehicles. Do we know which road to take? Infrastructure Partnerships Australia
108 Accenture (2014) The new road to the future: realising the benefits of autonomous vehicles in Australia. Accenture
109 City of Melbourne (2018) Transport strategy discussion paper car parking. City of Melbourne
110 Ambadaipudi A, Heineke K, Kampshoff P, Shao E (2017) Gauging the disruptive power of robo-taxis in autonomous driving. McKinsey & Company
111 International Energy Agency (IEA) (2018) Global EV outlook 2018: towards cross-modal electrification. IEA
112 Kane M, Whitehead J (2017) How to ride transport disruption–a sustainable framework for future urban mobility. Australian Planner, 54(3), 177-185.
113 International Transport Forum (2017) Income inequality, social inclusion and mobility. OECD
114 Bureau of Infrastructure, Transport and Regional Economics (2015) Traffic and congestion cost trends for Australian capital cities – Information sheet 74. Australian Government

FIGURE 30: VEHICLE STOCK PERCENTAGE BY ENGINE TYPE, 2015–2060



This figure shows the type of vehicles that are projected to make up Australia's vehicle stock modelled under the *Outlook Vision* scenario. The stock of vehicles in the combined category electric and hydrogen fuel cell vehicles is expected to be significantly dominated by electric vehicles to at least 2060.

FIGURE 31: EMISSIONS BY TRANSPORT MODE, 2015–2060



This figure shows the projected annual emissions from transport modes through to 2060 under the *Outlook Vision* in a cooperative global context. Under a fractious global context, both the *Outlook Vision* and *Slow Decline* scenarios indicate a similar drop in transport emissions with passenger vehicles falling from 43 $MtCO_2e$ to between approximately 11 and 10 $MtCO_2e$. However, as shown in the figure, under a cooperative global context, emissions from passenger vehicles would fall even further, reaching just under 3 $MtCO_2e$, with total domestic transport emissions falling almost twice as much as than under the *Outlook Vision* in a fractious global context.

BOX 7: Regional and rural alternatives to complement world class cities

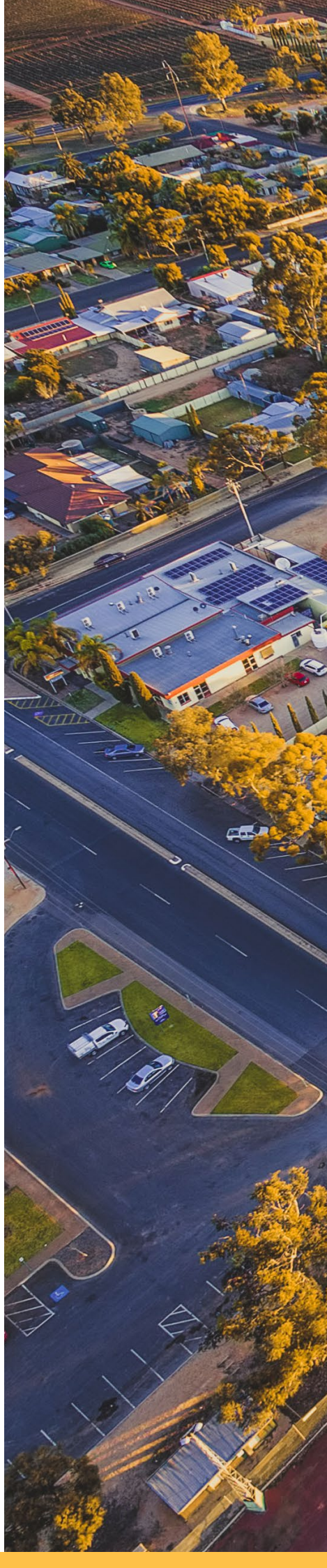
Alongside changes to make Australia's capital cities more well-connected and affordable, there is a significant opportunity to both preserve the strength of inland regional towns and rural communities and invest in the growth of regional satellite cities with strong connectivity to those capitals.

Many non-capital Australian cities, such as Geelong and Newcastle, already have diversifying economies, with sizeable populations growing at rates comparable to those of major cities. The *Outlook Vision* explored these trends continuing, with better planning, transport and services in these cities, by looking at a subtle modification to the *Outlook Vision* called *Stronger Regions*. Compared with the population distribution assumptions in the *Outlook Vision* scenario based on ABS data,[115] in this *Stronger Regions* scenario, by 2060 approximately 5 million more citizens would choose to live outside capital cities, choosing more spacious, traditional housing options and suburban lifestyles. This equates to each of those dozen or so satellite cities growing by an additional 10,000 residents each year.[116]

The amount of regional infrastructure needed is well within the bounds of Australia's available capital, and is of a scale consistent with historic growth. Under the *Stronger Regions* scenario, the average density of Australia's cities would be lower. This is a win for both regional satellite and capital city residents, because capital city density would otherwise increase by 60–88%. In addition, as the regional cities grow, improved services and amenities attract new residents, creating a positive feedback loop.

A move of population and services to satellite cities that are tightly connected to the capital cities would improve the quality of life and opportunities for both**.** People who are unable to afford housing in major cities could choose to leave and pursue alternative lifestyle and employment opportunities in the connected satellite cities. Even now, more than 40,000 people leave Sydney for regional New South Wales each year. Even with some migration in the opposite direction, the net internal migration to regional New South Wales is still 20,000 per year.

The opportunity for attracting population and services to these satellite cities is different to the opportunity for Australia's inland regional towns, where there is a clear need to maintain adequate services and infrastructure and preserve the health of Australia's rural communities and industry. Satellite cities are within two hours of a capital, and offer lower housing costs with access to international airports, major hospitals and international events. Their prosperity is driven largely by the economy as a whole and by the capital cities, whereas regional towns are tied more to the rural economy. Similarly, the lifestyles of satellite cities are largely coastal and suburban, rather than rural. With fast transport, such as high-speed rail, and improved digital connectivity, satellite cities would offer access to capital city employment.



115 Australian Bureau of Statistics (ABS) 3222.0 – Population projections, Australia, 2012 (base) to 2101. ABS, Canberra

116 Further details available in Australian National Outlook 2019: Technical report

4.3 Energy shift: Affordable, reliable, low-emission energy

In the *Outlook Vision*, Australian energy productivity and low-emission technologies offer affordable, reliable energy and create new opportunities and sources of comparative advantage.

SELECTED *OUTLOOK VISION* MEASURES

Renewables (including biofuels) account for **25–37%** of total primary energy use, including almost **100%** of electricity generation.

Total energy consumption increases by only **6%**, despite population growth of more than **60%**.

Households spend between **58–64%** less on electricity, relative to incomes.

Under a cooperative global context, Australia hits **net-zero emissions** by 2050, and can go further to achieve negative emissions of **-399 $MtCO_2e$** by 2060.

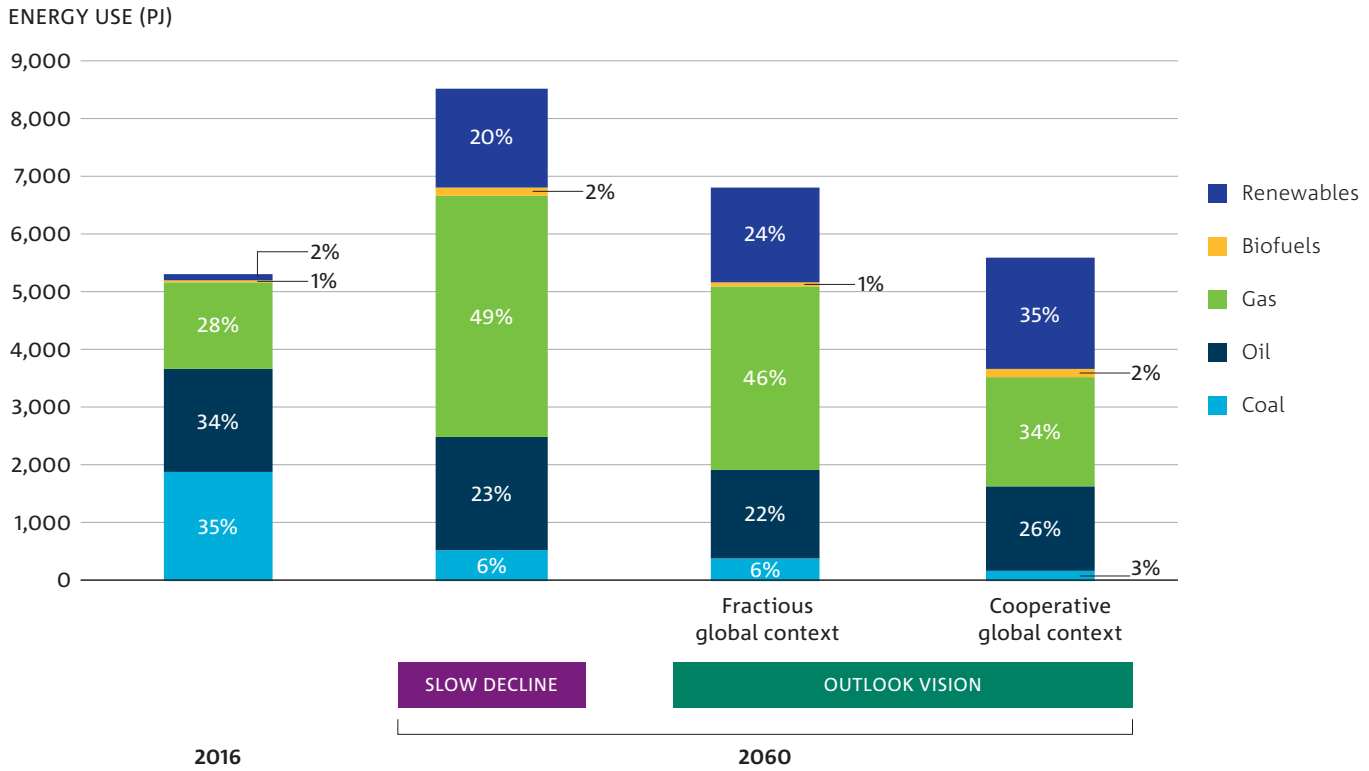
THREE LEVERS THAT SUPPORT AFFORDABLE, RELIABLE, LOW-EMISSION ENERGY INCLUDE:

- **Transition to low-emissions electricity:** investment in an affordable, reliable, low-emission electricity system delivers more electricity with almost no greenhouse gas emissions for industrial, transport and domestic needs.
- **Improve energy productivity:** businesses and households can use readily available technologies to get more value from each unit of energy, or switch to using lower-cost, low-emission electricity.
- **Develop new energy exports:** as risks emerge for traditional energy exports, Australia can start to export hydrogen, as well as electricity via high-voltage direct current (HVDC) power, offsetting declining fossil fuel export revenue and supporting the abatement efforts of nations with limited renewable resources.

4.3.1 TRANSITION TO LOW-EMISSIONS ELECTRICITY

A market-driven global energy disruption occurs under both the *Slow Decline* and *Outlook Vision* scenarios (Figure 32). This is most notable in electricity that is produced from primary energy sources. In all scenarios, by 2060 almost all electricity is generated by zero-emissions renewables. This transition is driven by economic rationale due to continuing reductions in the cost of renewable electricity generation technologies. Global renewable electricity investment is already greater than investment in new generation from coal and gas combined, and developing countries are the leading markets for new renewable energy generation.[117] In Australia, most of the transition to renewables is expected to occur between 2020 and 2040 as ageing coal-fired power plants are retired and replaced with renewable capacity (Figure 33).

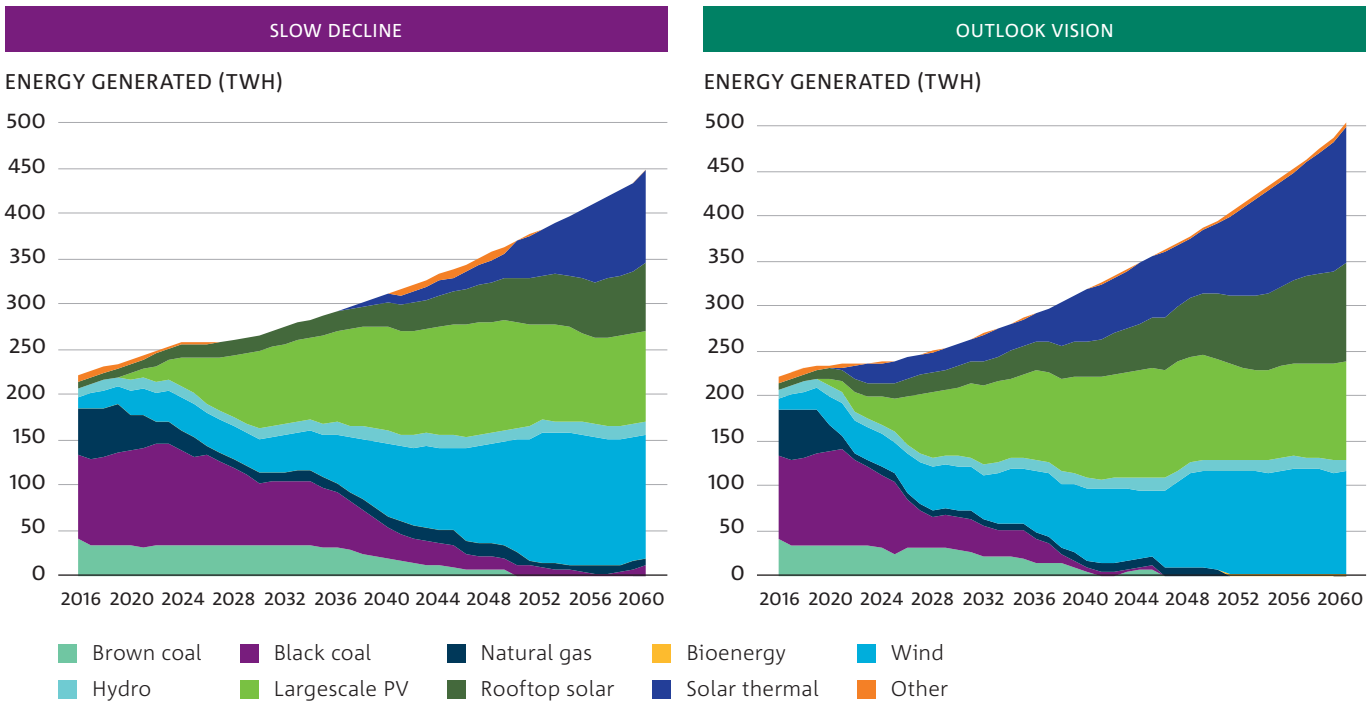
FIGURE 32: PRIMARY ENERGY USE IN AUSTRALIA



This figure shows primary energy use in Australia under the modelled scenarios, where primary energy is the measure of energy before it has been converted or transformed. The primary energy use results are broader than electricity and include the combustion of fuels in industry, commercial, residential and transport. The profile of primary energy use differs significantly by 2060 relative to 2016. Although the shares of different fuel types differ, broad trends of declining coal and oil, and the rising use of renewables and gas, are similar across the *Slow Decline* and *Outlook Vision* scenarios.

117 United Nations Environment Programme, Bloomberg New Energy Finance (2018) Global trends in renewable energy investment 2018. Frankfurt School of Finance & Management

FIGURE 33: ELECTRICITY GENERATION MIX



These figures show the modelled projections of electricity generation sources in terawatt hours (TWh), comparing the *Slow Decline* and *Outlook Vision* scenarios. By 2060, the electricity generation mix is broadly similar across scenarios, with almost all electricity produced from renewable energy sources. This transition to high renewables penetration is faster in the more cooperative global context compared with that under *Slow Decline*.

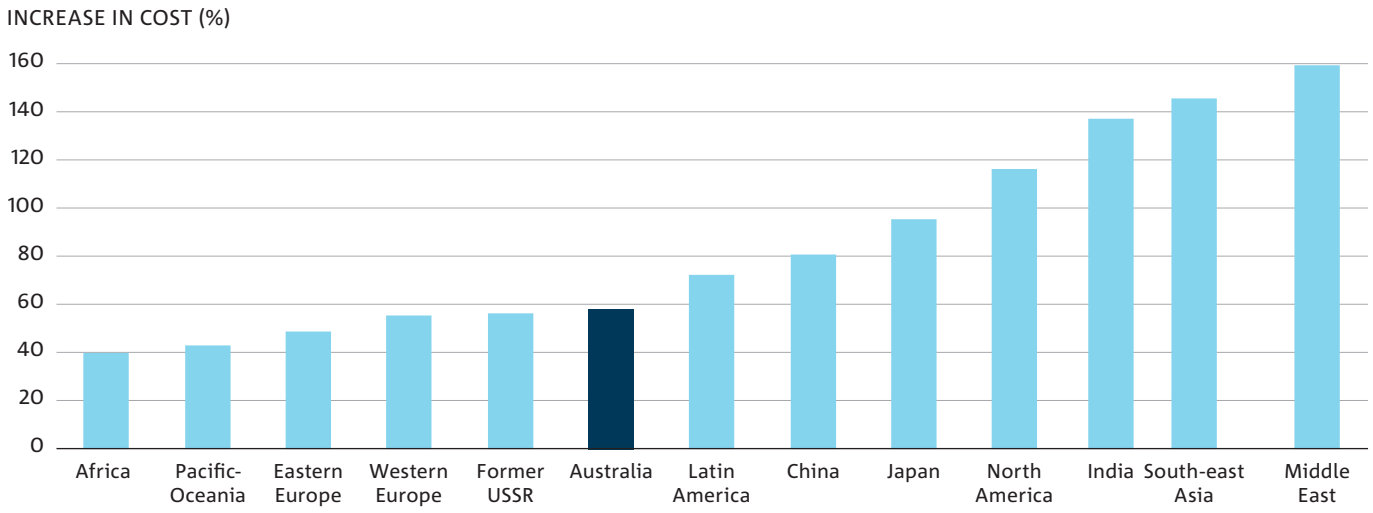
The transition to renewables as the primary source of electricity generation requires energy storage and ancillary services to support increasing energy demand and to manage the variability of renewables. Electricity reliability can be maintained through mechanisms such as batteries and pumped-storage hydroelectricity, or pumped hydro, combined with backup gas generation. More digital controls through distribution and transmission networks will also reduce the cost of large-scale, decentralised energy storage.

Although other countries will also be pursuing energy productivity and adopting renewables, modelling suggests that Australia's vast natural resources for renewable generation should lead to lower-cost electricity in 2060 (see Figure 34). High levels of solar irradiation mean that solar plants can operate at higher utilisation for more of the year in Australia than almost anywhere else on Earth, and there is more than enough land and rooftop space for them.[118] In addition, Australia's wind resources are among the world's best, particularly on the western and southern coasts, and many other renewable energy sources, like geothermal, wave and tidal resources, remain untapped.[118] Many of these resources are close to largely coastal populations, reducing overall distribution costs.

The switch to reliable low-cost, low-carbon electricity is facilitated by investor confidence in the long-term policy and regulatory environment. Under these conditions, local and global investors can confidently invest the large amounts of capital required to replace ageing-generation infrastructure. Without stable policy and the investment that flows from it, investors would require higher rates of return, resulting in a cost of wholesale energy that is higher than all other scenarios in the medium term, alongside a slower reduction in emissions (see Figure 35).

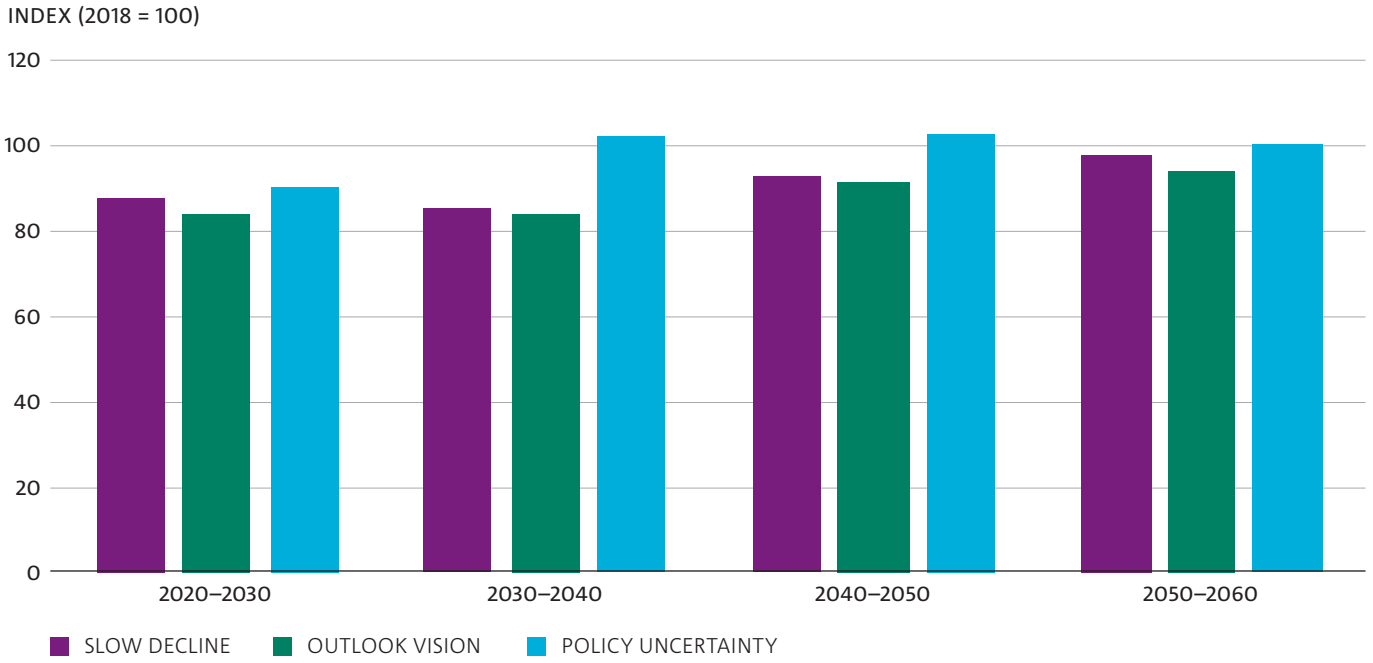
118 Geoscience Australia and Department of the Environment and Energy (2018) Australian energy resources assessment. Australian Government

FIGURE 34: INCREASE IN LEVELISED COST OF ELECTRICITY IN 2060 UNDER A COOPERATIVE GLOBAL CONTEXT



This figure shows the projected increase in the levelised cost of electricity (i.e. the cost of electricity necessary for an electricity generating asset to break even over its lifecycle) for selected regions for the *Outlook Vision* scenario in a cooperative global context. Although the levelised cost of electricity rises across all regions globally to 2060, Australia performs relatively well under a cooperative global context. This suggests an improvement in Australia's competitiveness with regard to electricity costs.

FIGURE 35: RETAIL ELECTRICITY COSTS, DECADAL AVERAGES



This figure shows total system costs of electricity delivery, indexed to 2018, under policy uncertainty relative to the *Slow Decline* and *Outlook Vision* (in a fractious global context) scenarios. Policy uncertainty increases costs due to higher risk premiums in required rates of return on invested capital. The higher costs in the policy uncertainty scenario are more significant in the earlier than later decades. Further details available in *Australian National Outlook 2019: Technical report*.[12]

4.3.2 IMPROVE ENERGY PRODUCTIVITY

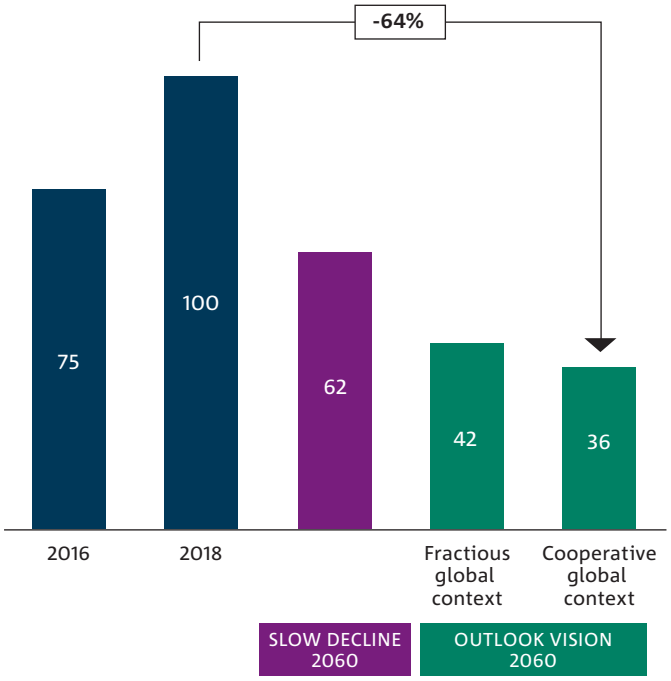
Conscious of both costs and emissions, businesses and households can use readily available technologies to get more value from each unit of energy they use and switch to lower-emission sources to deliver more productive outcomes.

In the *Outlook Vision*, households take advantage of energy efficiency and affordable low-emissions energy to reduce electricity costs. With rising wages and improved energy efficiency, by 2060 Australians are spending between 58% and 64% less on electricity as a proportion of income than they are today (see Figure 36, Figure 37). These productivity measures greatly help mitigate the risk of energy poverty (see Box 8).

Using available technologies, Australian industry has the opportunity, through continuous improvement, to become one of the most productive users of energy in the world by adopting the most efficient technologies (Figure 38).

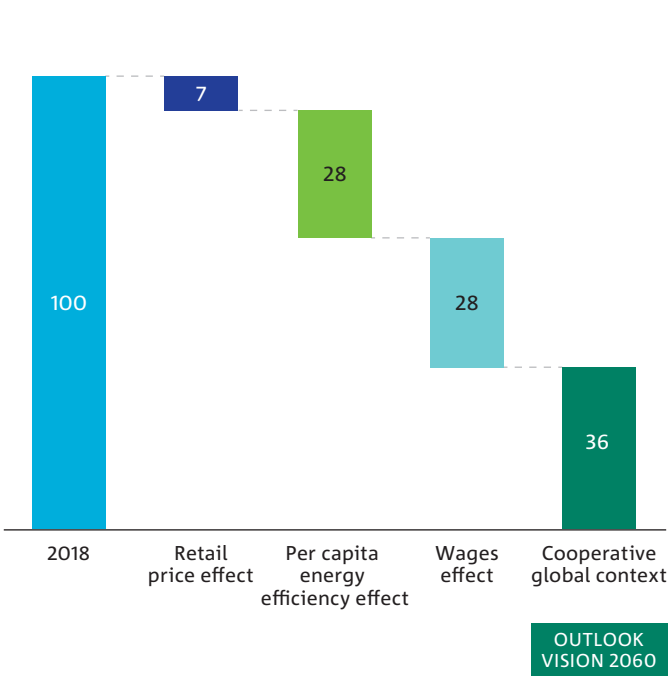
The two main drivers for achieving this more productive use of energy are energy efficiency and electrification. First, Australia can adopt available cost-effective technologies to become more energy efficient in homes, businesses and behaviours. One thing that would need to change is the rate of adoption, in line with global best practices and leveraging best-in-class technology. Although rates of uptake have been slow to date, they could be increased by incentive schemes or different business models.[119]

FIGURE 36: ELECTRICITY COSTS RELATIVE TO WAGES BY SCENARIO, INDEXED (2018 = 100)



This figure shows the potential electricity affordability improvements across the *Slow Decline* and *Outlook Vision* scenarios, indexed to 2018, with lower values representing improved affordability. Electricity affordability improves in all scenarios, represented as a declining per capita electricity spend as a proportion of wages. This result is a product of retail prices, energy efficiency improvements and wages growth, and is most pronounced in the *Outlook Vision* under a cooperative global context.

FIGURE 37: DECOMPOSITION OF CHANGES IN ELECTRICITY AFFORDABILITY UNDER THE *OUTLOOK VISION* SCENARIO IN THE COOPERATIVE GLOBAL CONTEXT



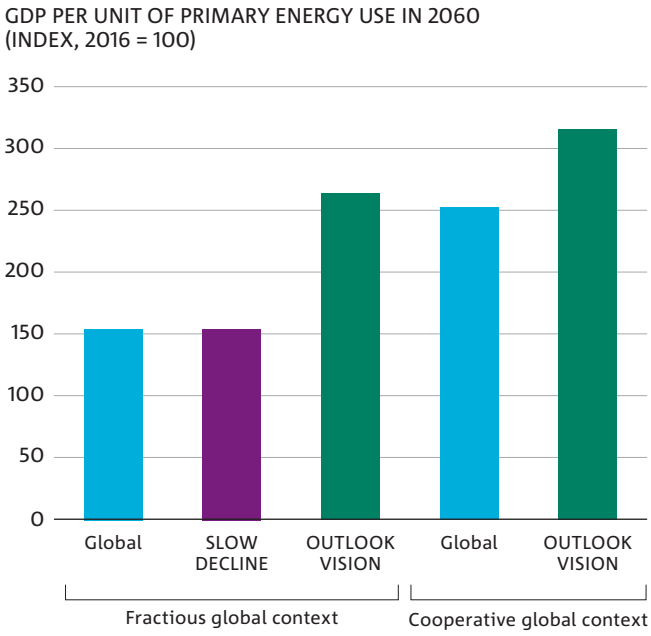
This figure shows the relative contribution of the different components of electricity affordability in the *Outlook Vision* under a cooperative global context. Improvements in energy efficiency per capita and wages growth account for nearly 90% of the change by 2060, with the remainder due to slightly lower retail prices relative to 2018. Figures have been rounded to nearest whole number.

119 Campey T, Bruce S, Yankos T, Hayward J, Graham P, Reedman L, Deverell J (2017) Low emissions technology roadmap: technical report. CSIRO

In the *Outlook Vision*, by 2060 industry and households are able to use more affordable and reliable electricity for greater energy productivity. For example, if households take advantage of the low-cost, low-emission electricity by switching from natural gas to low-carbon electricity, electrical space heating could be up to sixfold more energy efficient than gas heating for the same result.[120] Similarly, as detailed in Section 4.2, electric vehicles are projected to be the cheapest form of transport after 2025 and to dominate sales by 2040 (Figure 30). The improvements in energy productivity from energy efficiency and fuel switching mean that the economy is able to produce more than threefold the output for each unit of energy compared to today. This results in an economy that is less sensitive to changes in energy costs and more competitive than that of other countries.

Energy productivity can also alleviate supply constraints, such as potential shortages in the supply of gas. Gas demand from the economy can be reduced substantially in the *Outlook Vision* relative to *Slow Decline*. However even in the *Outlook Vision*, demand for gas may exceed the supply from prospective gas resources on the east coast.[121] Growth in gas demand on the east coast would place pressure on gas prices, requiring further development of resources or importing gas from other regions or overseas. Although modelling by the International Energy Agency (IEA)[122] suggests that there is strong potential for further increases in gas production in Australia, shortages of low-cost gas on the east coast may persist. Planning for future regional energy needs will be required to avoid the most costly options of dealing with regional shortages of gas.

FIGURE 38: ENERGY PRODUCTIVITY



This figure shows the improvements achieved in energy productivity across the modelled scenarios by 2060, with higher values representing more productive use of energy. Values have been indexed to 2016. Energy productivity is presented here in terms of primary energy used per unit of GDP. In the *Outlook Vision* scenarios, energy productivity improves relative to international peers by 2060, regardless of global context. This is driven by the combined effects of strong economic growth and, particularly in a cooperative global context, decreasing energy intensity. This equates to significantly improved energy competitiveness in the *Outlook Vision* over the course of the period modelled.

120 International Energy Agency (IEA) (2011) Technology roadmap, energy-efficient buildings: heating and cooling equipment. IEA

121 Australian Energy Market Operator (AEMO) (2018) Gas statement of opportunities. AEMO

122 International Energy Agency (IEA) (2018) World energy outlook. IEA

BOX 8: Energy poverty

'Energy poverty' means being unable to access the energy needed for well-being. Today, almost 6% of Australian households suffer from energy poverty,[123] meaning that they are choosing to go without energy for desired heating, cooling or cooking as a consequence of financial strain.

Despite a fall in the average number of people per household from 3.0 in the 1980s to 2.6 in 2016,[124] weekly household spending on energy increased from $32.50 in 2009–10 to $40.90 in 2015–16, and now accounts for 2.9% of household income.[125] However, as a proportion of disposable income, households in the lowest income bracket spend approximately fivefold more on electricity than those in the highest income bracket.[126] This, in part, leads to 0.8–1.6% of electricity customers being disconnected for failure to pay in Australia's larger states.[127]

The risk of energy poverty is higher for pensioners, people living in poor-quality housing or in rental properties, Aboriginal and Torres Strait Islander people, single parents and their children, newly arrived migrants and refugees and people with a disability.[128]

Those at risk also have fewer options to reduce their energy costs. Efficiency investments, such as solar panels, double-glazed windows, insulation and energy-efficient appliances, have significant upfront costs. Renters, who account for 30% of the population, face additional barriers in making their homes more energy efficient.[129]

Addressing energy poverty in Australia will require support from Government and Industry. This will depend on factors including the direction of future energy prices, investment and access to energy efficiency technologies, particularly for low-income and disadvantaged households, and consumer education.[128,130]

4.3.3 DEVELOP NEW ENERGY EXPORTS

Energy productivity can improve the competitiveness of Australian businesses and reduce financial strain on households. However, effective global action on climate change means a tougher long-term trading world for one of Australia's largest export sectors, raw energy in the form of liquid natural gas (LNG) and coal. Australia is well positioned to develop new energy exports that leverage Australia's natural resource advantage, such as energy in the form of hydrogen[89] or even electricity through HVDC transmission.[131]

In all scenarios modelled, global coal demand declines steadily through to 2060 (Figure 39). Alongside the global decline in demand for coal, the modelling suggests that hydrogen can become a commercially viable energy carrier from 2030, and cheaper than LNG from 2036, given a strong carbon price to limit global warming to 2°C by 2100 (Figure 40). In addition, Australia may be well positioned to become a major exporter of hydrogen due to its natural energy resources and its LNG engineering knowledge. In the 2018 World Energy Outlook, the International Energy Agency (IEA) highlighted Australia for its vast potential to produce hydrogen from renewable energy for export, calculating that Australia could produce nearly 100 million tonnes of oil equivalent of hydrogen, equating to 3% of global gas consumption.[132] A recent report commissioned by the Australian Renewable Energy Agency (ARENA) examined the hydrogen export opportunities for Australia, estimating that by 2040 demand could be valued at between $2.6 billion and $13.4 billion, followed by a continued growth projection.[133] In that report, over $4b in associated economic contribution due to the development of the industry is projected by 2040, as well as opportunities for over 7,000 full-time equivalent jobs.

123 This definition for 'energy poverty' counts households that receive less than 60% of median net household income and spends 10% or more of its net income on energy expenses. These households are less likely to heat their homes sufficiently and meet energy expenses. Source: Energy Consumers Australia & St Kitts Associates (2013) Relative Energy Poverty in Australia.

124 Australian Institute of Family Studies (2018) Population and households. Australian Government

125 Salt B, Hogan C (2017) Census insights: the rise of energy poverty in Australia. KPMG

126 Australian Competition & Consumer Commission (2017) Retail Electricity Pricing Inquiry – preliminary report. Australian Government

127 Australian Energy Regulator (2014) State of the energy market. Australian Competition & Consumer Commission

128 Australian Council of Social Services (ACOSS) (2017) Empowering disadvantaged households to access affordable, clean energy. ACOSS

129 Energy Australia (2017) Better energy: how to make your home more energy efficient. Energy Australia

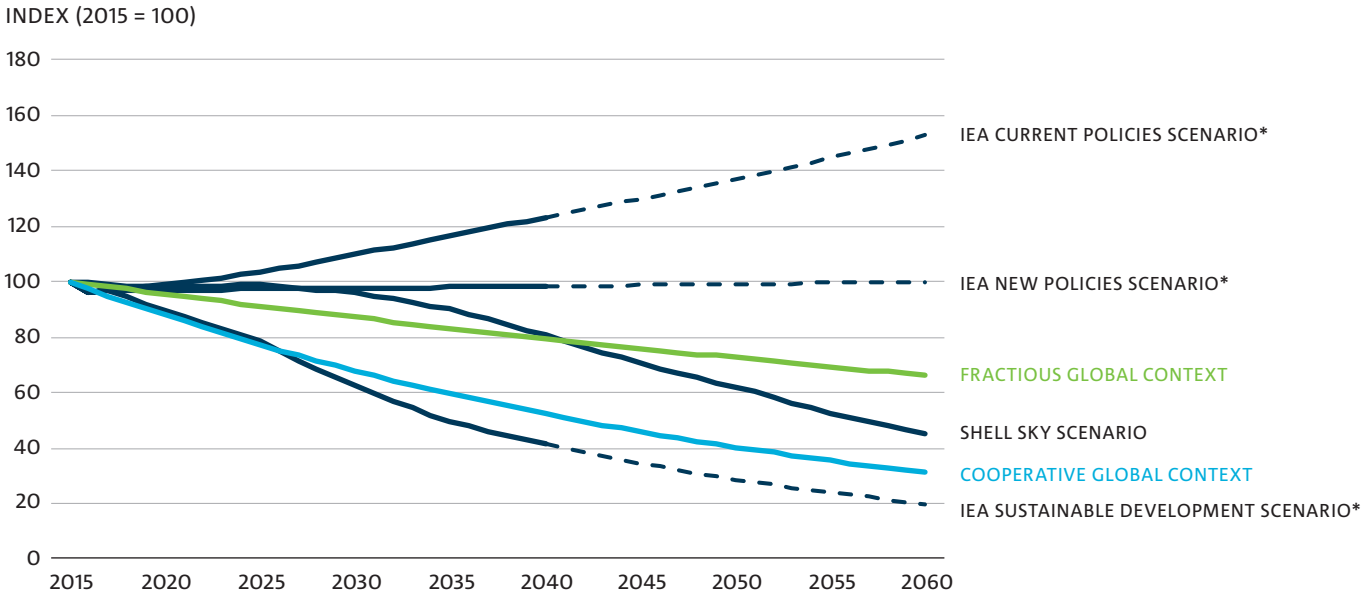
130 Nance A (2017) The energy project: energy access and affordability policy research. The Energy Project

131 Halawa E, James G, Shi X, Sari N, Nepal R (2018) The prospect for an Australian-Asian Power Grid: A Critical Appraisal, Energies 11(1):200

132 International Energy Agency (IEA) (2018) World energy outlook 2018. OECD

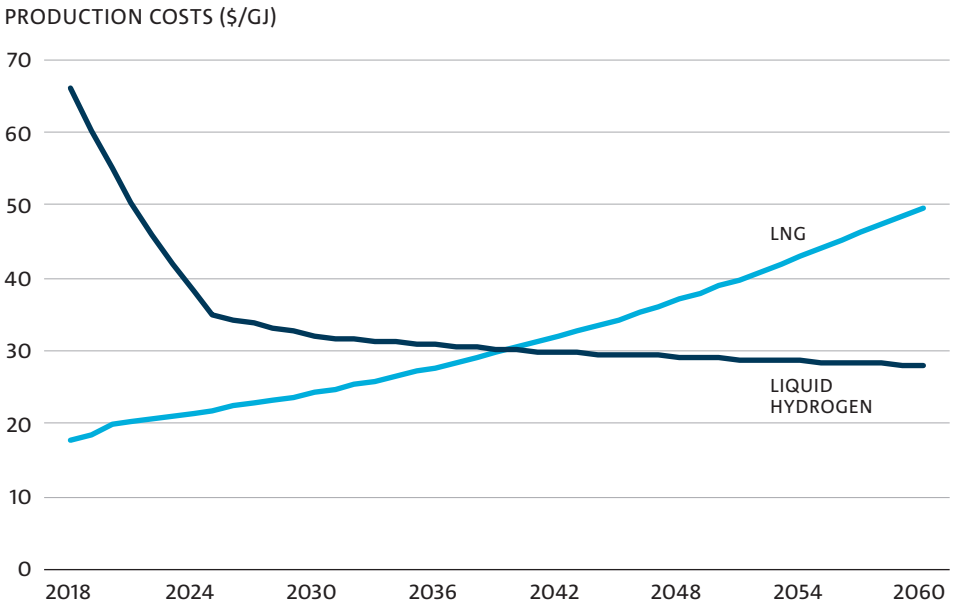
133 Acil Allen Consulting for ARENA (2018) Opportunities for Australia from hydrogen exports. Acil Allen Consulting

FIGURE 39: GLOBAL COAL DEMAND IS PROJECTED TO DECLINE TO 2060



This figure shows global coal demand projections from CSIRO modelling compared to projections from the International Energy Agency (IEA)[122] and Shell's Sky scenario.[134] Indexed to 2015, global coal demand is projected to decline by 2060 in the *Outlook Vision* under both a fractious and cooperative global context. This reduction is more significant in a cooperative context due, in part, to the higher carbon price associated with stronger international action on climate change. *IEA estimates extrapolated from 2040 to 2060.

FIGURE 40: PRODUCTION COSTS OF LIQUEFIED NATURAL GAS (LNG) VERSUS LIQUID HYDROGEN FUEL



This figure shows the production costs of LNG compared with liquid hydrogen, modelled through to 2060 under the *Outlook Vision* scenario in a cooperative global context. Cost comparisons with LNG production suggest that hydrogen could become an export opportunity, reaching cost parity around 2040, after including the carbon price assumptions associated with a more cooperative global context.

134 Shell (2018) Meeting the goals of the Paris Agreement: Temperature implications of the Shell Sky scenario: the numbers behind Sky. Shell

4.4 Land shift: Healthy and productive landscapes

In the *Outlook Vision*, Australia's landscapes are filled with a profitable and sustainable mosaic of food, fibre production, carbon sequestration and biodiversity.

SELECTED *OUTLOOK VISION* MEASURES

Returns to landholders could increase to as much as **$114 billion** (more than doubling relative to Slow Decline).

Carbon plantings could offset up to **700 $MtCO_2e$** of emissions by 2060.

Long-term conservation of Australia's valuable natural assets can be achieved through reforestation and land remediation.

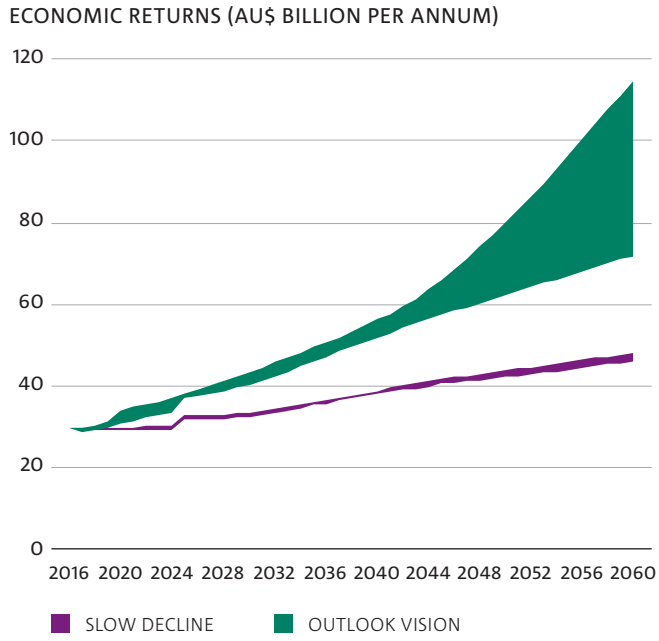
THREE LEVERS THAT SUPPORT HEALTHY AND PRODUCTIVE LANDSCAPES INCLUDE:

- **Invest in productivity:** leverage Australia's strong agriculture industry and lift food and fibre productivity by harnessing digital and genomic technology as well as by using natural assets more efficiently.
- **Capitalise on emerging markets:** participate in new agricultural and environmental markets at a globally significant scale to provide opportunities for alternative revenue streams on less-productive land, such as carbon forestry.
- **Restore ecosystem health:** recognise that without maintaining, restoring and investing in ecosystem health, agricultural productivity targets cannot be achieved.

4.4.1 INVEST IN PRODUCTIVITY

Under the *Outlook Vision*, Australia increases its agricultural productivity (land use efficiency) to 3% per annum, allowing Australia to remain globally competitive (Figure 41) and contribute to growing global food demand. This is significantly higher than under *Slow Decline*, in which agricultural productivity sits at 1.25% per annum. Increasing productivity could result in revenue for crops such as winter cereals doubling by 2060, more than offsetting an increase in costs. Increasing productivity also provides resilience against hotter and drier conditions with more droughts that could otherwise make agriculture less viable. This level of productivity is a stretch goal that can be achieved by intensifying agriculture on the best land, taking advantage of knowledge and experience from the best farmers and improving productivity throughout the full supply chain using emerging technologies, supported by access to finance and the right market incentives.

FIGURE 41: ECONOMIC RETURNS TO LANDHOLDERS



This figure shows returns to landholders given the on-farm productivity achieved in each scenario and the potential for land use change. The shaded area of *Outlook Vision* represents the range of outcomes possible depending on the global context and the range of modelled impacts of future climate change. The variation across climate futures is indicative of the complex interplay between the impacts of climate on modelled agricultural production and tree growth, among other factors. These results confirm that additional income from other land use change can more than offset any reductions in agricultural production due, in part, to the fact that agricultural production concentrates on more productive land, with less productive land transitioned to other uses. Economic returns are calculated as profit at full equity for agriculture and annualised net present value over a 100-year time horizon for reforestation land uses.[135]

135 Bryan A, Nolan M, McKellar L, Connor J, Newth D, Harwood T, King D, Navarro J, Cai Y, Gao L, Grundy M, Graham P, Ernst A, Dunstall S, Stock F, Brinsmead T, Harman I, Grigg N, Battaglia M, Keating B, Wonhas A, Hatfield-Dodds S (2016) Land-use and sustainability under intersecting global change and domestic policy scenarios: trajectories for Australia to 2050. Global Environmental Change 38, 130–52

Distance, complexity and small populations have so far constrained the digital revolution in agriculture,[136] leaving it as one of Australia's least digitally and technologically enabled sectors.[137] Overcoming these constraints will bring significant opportunities to improve productivity in agriculture through technology adoption.[138]
This will require research and development (R&D) and capacity building, as well as the deployment of new and diverse practices.[139] In particular, this includes the adoption of real-time decision support technologies to achieve the yield potential of land and agricultural systems, and the adoption of new genomic insights and tools to raise that yield potential.[140] This achievement will need to consider and adapt to future changes in climate (and their spatial variability).[141] Already, over the past 25 years Australia has seen climate variability and climate change reduce yield potential (but not yet yield) in some of its major systems by as much as 10%.[142]

Adding to the challenge of increasing productivity is the fact that total factor productivity growth has declined in agriculture since the mid-1990s, both globally and in Australia.[143] Putting aside climate variability and the Millennium Drought between 1997 and 2009, Australia has not invested sufficiently in the R&D needed for this level of technical innovation.[144] After adjusting for climate effects, the productivity growth rate for cropping has slowed from 2.15% in the 1990s to 1.06% per annum through the 2000s.[145] Outside of cropping, productivity growth was slower, and in some areas actually declined.[146]

Still, tripling the current productivity growth rate to reach 3% average annual gains is possible. Australian farmers have achieved this before through a series of innovative leaps rather than a steady accumulation of changes.[147]

In a story that is similar to energy productivity, many farms have been able to reach or exceed those rates over the past decade, so the gains are available. The issue is how to broaden and accelerate those gains across the rural economy, while retaining rural community vitality. The potential gains from digital and genomic technologies provide an opportunity in the *Outlook Vision* to offer reduced labour costs, increased timeliness and efficiency and better market connections. For example, gains in broad acre cropping using data-rich satellite imagery are estimated to reach $221 million annually by 2025, up from $17 million in 2015.[148]

These productivity gains are also necessary.
Without productivity growth, farms would face declining profitability due to rising costs and falling prices, just as they would for long periods under the low productivity rates of *Slow Decline* (Figure 42). In addition, the chances of farmers withstanding adverse conditions, which will be more likely due to climate change, would be reduced. For example, the modelling has tested Australia's resilience to future climate variability by imposing the rainfall and temperature conditions of the Millennium Drought onto winter cereal profitability in the 2040s (see Box 9), demonstrating the potential for drought to have a substantial effect on both the short- and long-term profitability of production. With growing recognition of the risks to productivity and profitability from the environment, there is much the finance and insurance sectors can do to support farmers in sustaining production and push production frontiers in an uncertain and changing environment. To be strongly profitable, agriculture needs both productivity growth and ecosystem health (see Section 4.4.3).

136 Leonard E, Rainbow R, Trindall J, Baker I, Barry S, Darragh L, Darnell R, George A, Heath R, Jakku E, Laurie A, Lamb D, Llewellyn R, Perrett E, Sanderson J, Skinner A, Stollery T, Wiseman L, Wood G, Zhang A (2017) Accelerating precision agriculture to decision agriculture: Enabling digital agriculture in Australia. Cotton Research and Development Corporation

137 McKinsey & Company (2017) Digital Australia: Seizing the opportunity from the Fourth Industrial Revolution. McKinsey Global Institute

138 StartupAUS, KPMG, Commonwealth Bank, Queensland Government (2016) Powering Growth: Realising the potential of AgTech for Australia. KPMG

139 Bell J, Frater B, Butterfield L, Cunningham S, Dodgson M, Fox K, Spurling T, Webster E (2014) The role of science, research and technology in lifting Australian productivity. Australian Council of Learned Academies

140 National Farmers' Federation, KPMG (2018) Talking 2030: Growing agriculture into a $100 billion industry. KPMG

141 Rickards L, Howden SM (2012) Transformational adaptation: agriculture and climate change. Crop and Pasture Science 63, 240–50

142 Hochman Z, Gobbett DL, Horan H (2017) Climate trends account for stalled wheat yields in Australia since 1990. Global Change Biology 23, 2071–81

143 Fuglie K, Nin-Pratt A (2013) Agricultural productivity: a changing global harvest. International Food Policy Research Institute

144 Sheng Y, Gray EM, Mullen JD, Davidson A (2011) Public investment in agricultural R&D and extension: an analysis of the static and dynamic effects on Australian broadacre productivity. Australian Bureau of Agricultural and Resource Economics and Sciences

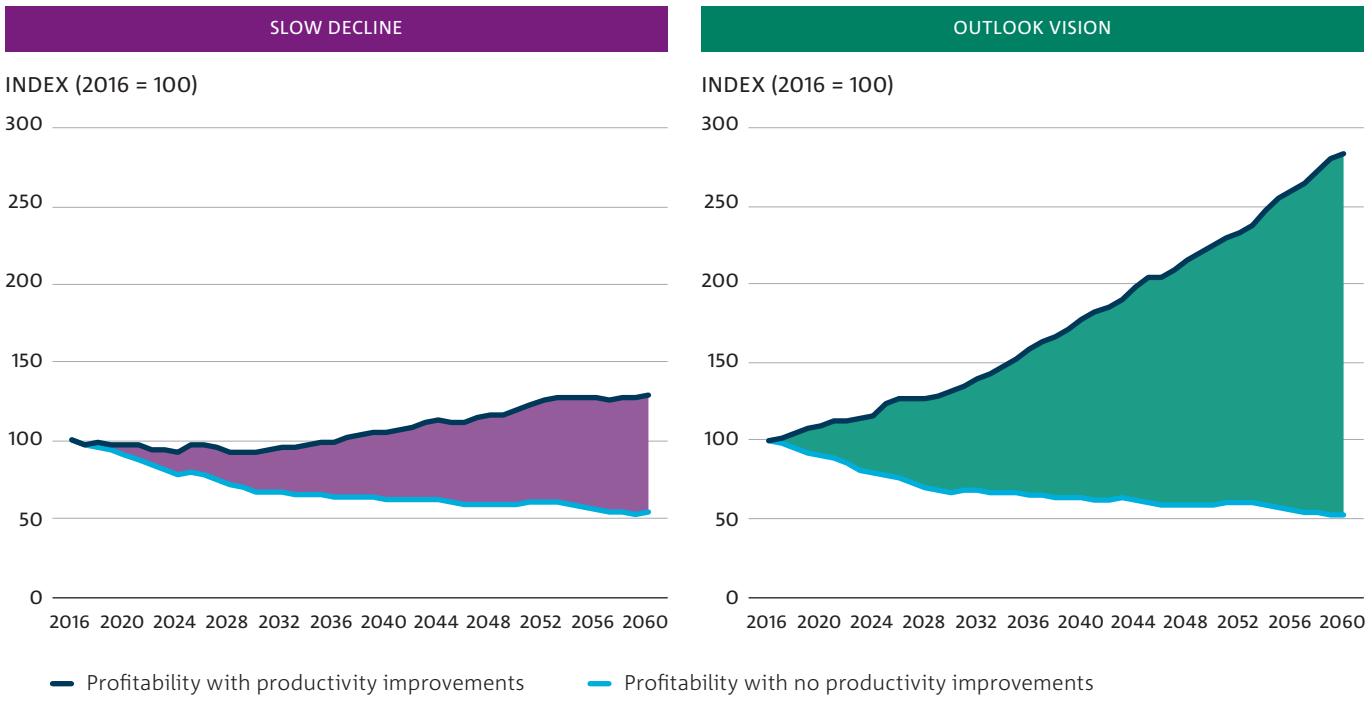
145 Hughes N, Lawson K, Davidson A, Jackson T, Sheng Y (2011) Productivity pathways: climate adjusted production frontiers for the Australian broadacre cropping industry. ABARES Research Report 11.5. Australian Government

146 Grundy MJ, Bryan BA, Nolan M, Battaglia M, Hatfield-Dodds S, Connor JD, Keating BA (2016) Scenarios for Australian agricultural production and land use to 2050. Agricultural Systems 142, 70–83

147 Angus JF (2001) Nitrogen supply and demand in Australian agriculture. Australian Journal of Experimental Agriculture 41, 277–88

148 Acil Allen (2015) The value of earth observations from space to Australia, CRC for spatial information. Acil Allen

FIGURE 42: PROFITABILITY FOR WINTER CEREALS



This figure shows profitability of winter cereals under the different scenarios given the productivity assumptions. The shaded areas represent the range of outcomes possible under each scenario. This highlights the importance of productivity improvements in combating the 'cost-price squeeze'. Declining profitability is observed over the entire modelling period under assumptions of no productivity improvements, indicated as profitability below a value of 100. Even under the productivity assumptions of *Slow Decline*, much of the period sees a declining profitability. Conversely, the productivity assumptions in the *Outlook Vision* see winter cereals profitability nearly triple by 2060.

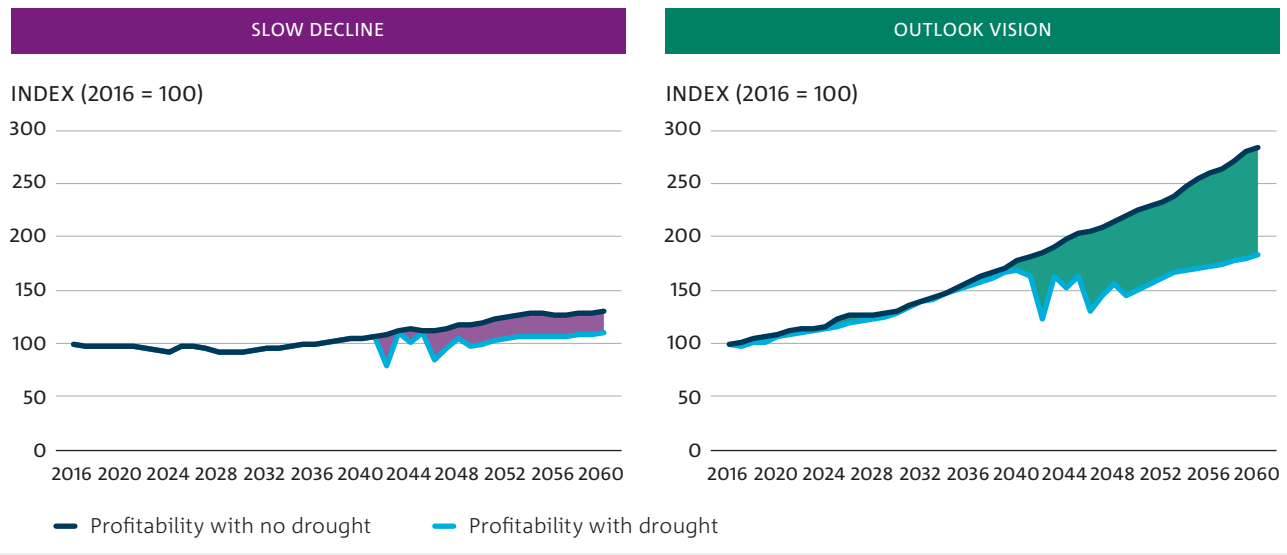
BOX 9: Effects of climate change

There are multiple lines of scientific evidence that the global climate system is warming and that humans influence the climate system through increases in greenhouse gases.[149] It is also clear that unmitigated global warming will cause economic loss both globally and in Australia.[150,151,152,153,154] In this report, the effects of climate change were explored qualitatively and quantitatively through mitigation and adaptation. Differences in mitigation effort (reducing greenhouse gas emissions) have been incorporated in the national results by applying a price on greenhouse gas emissions and through assumptions about technological development driving total factor productivity.

Although the costs and benefits of adaptation were not incorporated into the modelling results, the most reliable estimates aligned to the scenarios indicate that 4°C global warming without adaptation could lead to a global per annum GDP loss of 7.2% and an Australian per annum GDP loss of 1.6% by 2100.[154] If mitigation can limit the global warming to 2°C by 2100, the global per annum GDP loss would be reduced to 0.5–1.6% by 2050–60[150,151] and to 1.8% by 2100, and the Australian per annum GDP loss would be reduced to 0.6% by 2100.[154] The GDP loss would be further reduced by adaptation.[152]

Costs of adaptation were quantified at a sectoral level by exploring the effects of extreme events in agriculture. For example, the agricultural sector's resilience to future climate variability was tested by imposing the rainfall and temperature conditions of the Millennium Drought onto winter cereal profitability in the 2040s (Figure 43). This demonstrates the potential for drought to have a substantial effect on the profitability of production, which would place acute pressure on farmers in the short term, and potential chronic pressure in the long term. This analysis could be considered a worst-case scenario and is not intended to be predictive of the scale of events that may occur during the time period modelled, but it does demonstrate the short- and long-term effects on the profitability of production.

FIGURE 43: PROFITABILITY UNDER MILLENNIUM DROUGHT CONDITIONS



This figure shows the potential impacts of drought on farm profitability across the *Slow Decline* and *Outlook Vision* scenarios. The shaded areas represent the range of outcomes under the two scenarios. To illustrate the potential impacts of severe climate impacts occurring more frequently, a future drought event was modelled. Although accurately quantifying the impact of potential future extreme climate events is not possible, by simulating such an event this report is able to provide some guidance on the magnitude of potential impacts of climatic events that are expected to increase in frequency and severity under climate change. For more information, see the *Australian National Outlook 2019: Technical report*.[12]

149 Intergovernmental Panel on Climate Change (IPCC) (2014) Climate Change 2014 Synthesis Report Summary for Policymakers. IPCC

150 Stern N (2006) The Economics of Climate Change. Government of the United Kingdom

151 OECD (2015) The Economic Consequences of Climate Change. OECD Publishing

152 Diaz D, Moore F (2015) Temperature impacts on economic growth warrant stringent mitigation policy. Nature Climate Change

153 Garnaut R (2008) The Garnaut Climate Change Review: Final Report. WHH Publishing

154 Kompas, T, Pham VH, Che TN (2018) The Effects of Climate Change on GDP by Country and the Global Economic Gains From Complying With the Paris Climate Accord. Earth's Future 6, 1153–1173

4.4.2 CAPITALISE ON EMERGING MARKETS

Under a fractious global context, both the *Slow Decline* and *Outlook Vision* scenarios would see a mix of land use that is similar to present arrangements, influenced by interactions between prices, productivity trends and the range of market opportunities available. However, a cooperative global context with strong global action on climate change can present opportunities for landowners to sequester carbon through carbon and environmental plantings and other on-farm biosequestration approaches. This would deliver environmental and productivity benefits while diversifying and increasing the total revenue streams available, both through improved access to premium 'low-carbon' product markets and new income streams from carbon markets.

Such plantings would first offset Australia's own greenhouse gas emissions, contributing to global emission reduction commitments. Then, any additional emissions abatement would be available for sale as carbon credits to other countries that also need to meet commitments but do not have the land to pursue carbon sequestration on the scale possible in Australia.

Carbon sequestered in forests could be produced profitably on over 30 million hectares, equivalent to half of the more marginal agricultural land in Australia's intensive use zone (Figure 44). Supported by higher carbon price assumptions, planting on this scale means that returns to landowners could more than double to as much as $114 billion per annum (see Figure 41), growing land use industries as a share of national GDP from 2.1% to 5.2% by 2060. This translates to economic returns to landholders being between $37 billion and $63 billion higher in the *Outlook Vision* (under a cooperative global context) compared with the *Outlook Vision* (under a fractious global context) and *Slow Decline* respectively. This has the added benefit of directly supporting jobs and incomes in regional Australia. Most carbon forestry would be incorporated into agricultural landscapes as part of a 'mosaic' of land uses. Figure 45 shows how, under the *Outlook Vision*, the land may be divided into its most profitable and sustainable uses: intensive agriculture in the most productive areas, then livestock and finally a mix of carbon and biodiversity plantings in less tractable landscapes. Each component would be designed so that the natural capital of each segment is maintained or improved. In the *Outlook Vision*, high productivity levels allow overall agricultural production to grow to 2060, even with less available land in later years as the land mix diversifies.

Carbon and environmental plantings on this scale are a significant land use shift, and so require careful planning, consultation and engagement with the community, particularly regional communities. Such considerations will include protecting prime agricultural land for food and fibre production and avoiding adverse effects on water supplies. However, the assumed rate of change is consistent with historic innovations in the land sector, and includes time to gain community support, as well as build expertise and investment in infrastructure and logistics. The key driver is effective global action to limit warming to below 2°C, which translates to a global carbon price rising to $\$153/tCO_2e$ in 2050 and $\$274/tCO_2e$ in 2060.

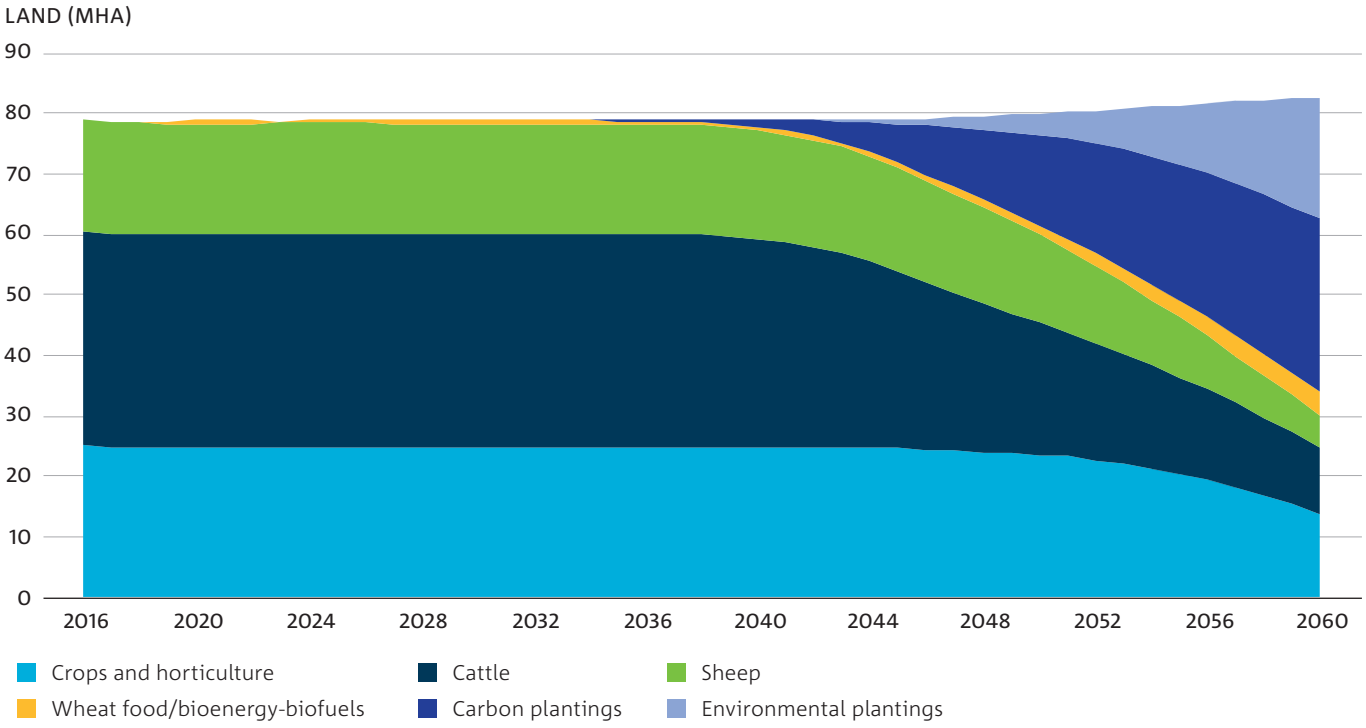
There is a discussion to be had as to whether to plant forests that sequester carbon in the greatest quantity or accept a reduced quantum of sequestration to increase biodiversity value from such plantings. The potential scale of this new industry brings an opportunity to develop a landscape level solution that satisfies multiple criteria: enough income to invest in diverse plantings, some to maximise carbon sequestration for immediate income and some to prioritise ecosystem restoration for the health of Australia's natural assets. Planting the right species in the right river catchments and corridors is the most effective large-scale path to restoring the ecosystem health upon which Australia's agricultural productivity and biodiversity depend.

An important consideration is that integration of afforestation (or assisted reforestation) into agricultural landscape can, in some cases, increase both the total productive value of the land (tree crops plus agricultural crops) and resilience of agricultural land,[155,156] although in drier landscapes crop competition can occur for significant distances from trees,[157] and practice will be strongly determined by product and carbon prices, as well as environmental incentives. Developing innovative methods for recognising value in increasing the carbon stores on agricultural land without land use change will create opportunities and incentives for land-sector engagement. Farm forestry activities such as shelterbelts, or increasing woodland density on pastoral areas and practices to increase soil carbon in managed landscapes support existing production while creating emissions abatement.[158]

Under the *Outlook Vision*, an optimal mix of carbon and environmental plantings could sequester as much as 260 $MtCO_2e$ in 2050, allowing Australia to reach zero net emissions in that year. With more effective global action on climate change, plantings could sequester between 400 and 700 $MtCO_2e$ by 2060, with approximately half that sequestration being sold to other countries.

Securing this shift would require at least three actions. First, there needs to be effective global action on climate change that accepts carbon farming as one of the many essential pathways. Second, there is a need for continued R&D, investment and the development of infrastructure, such as plant nurseries and distribution channels for plantations or new technologies for establishing carbon plantations. Third, Australia would need to ensure

FIGURE 44: LAND USE IN THE *OUTLOOK VISION* SCENARIO UNDER A COOPERATIVE GLOBAL CONTEXT



This figure shows the shift in land use modelled over the *Outlook Vision*. In a cooperative global context, there is a wider range of profitable land uses, such as biofuel production and carbon sequestration in monoculture or mixed-species plantings. There is significant emissions abatement potential associated with the level of land use change in this context, including emissions avoided in agriculture and through some displacement of fossil fuels by bioenergy.

155 Borek R, Balaguer F, Boosten M, Burgess P, Considine W, Csikvari J, Grandgirard D, Hannachi Y, Jäger M, Mezzalira G, Morhart C, Mosquera-Losada MR, Pecenka R, Poza L, Javier M, Ramos-Font E, Reubens B, Schmutz U, Sepp M, Zollner D, Vityi A (2017) EIP-AGRI Focus Group Agroforestry: introducing woody vegetation into specialised crop and livestock systems. Final Report. European Commission

156 Harper RJ, Beck AC, Ritson P, Hill MJ, Mitchell CD, Barrett DJ, Smettem KRJ, Mann SS (2007) The potential of greenhouse sinks to underwrite improved land management. Ecological Engineering

157 Sudmeyer RA, Daniels T, van Burgel A, Jones H, Huxtable D, Peck A (2012) 'Chapter 4 Tree and crop competition effects' in A. Peck et al. (eds), Productivity of Mallee agroforestry systems – the effect of harvest and competition management regimes. Rural Industries Research and Development Corporation

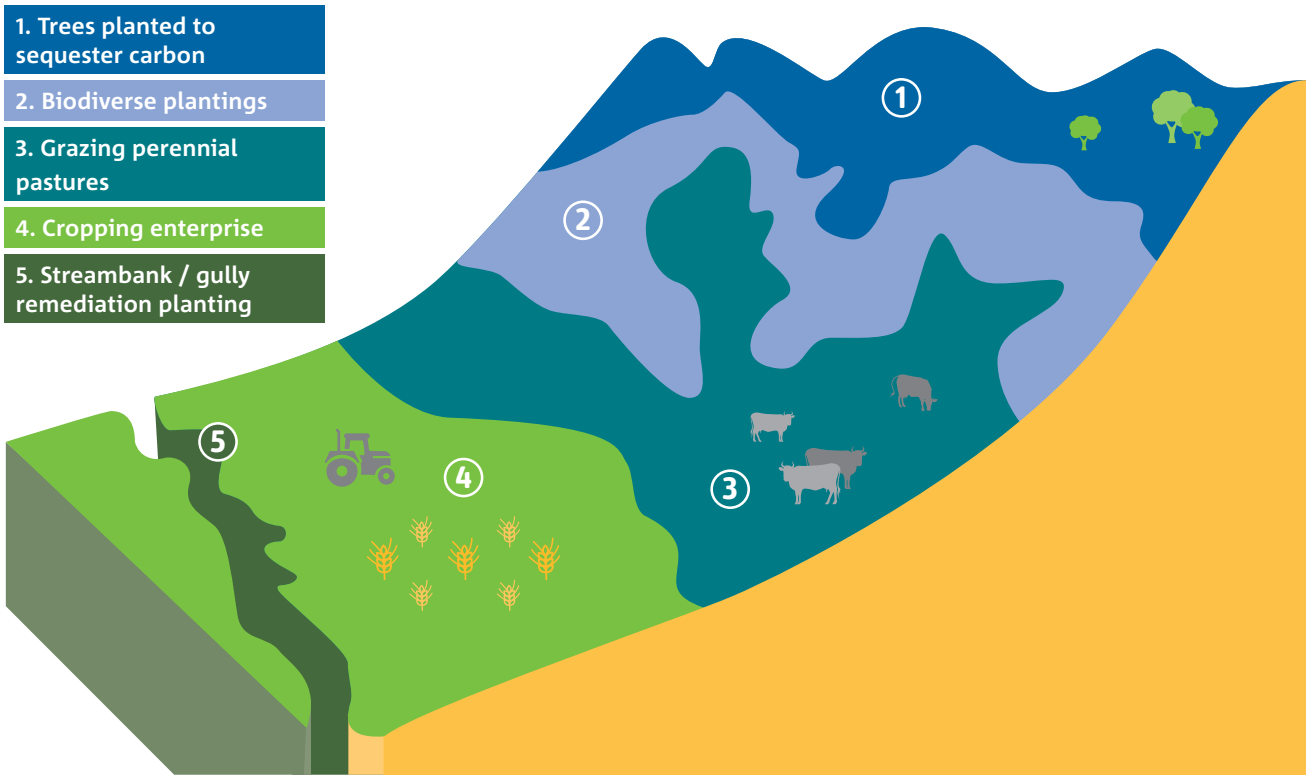
158 European Union (2017). EIP-AGRI Focus Group Agroforestry: introducing woody vegetation into specialised crop and livestock systems

that the on-farm and landscape-wide benefits of this form of carbon farming, resulting from the broader range of income from land management changes, also create benefits for rural communities and the natural environment (see Box 10).

The capacity to sequester greenhouse gases in the land depends on a number of ecological factors, such as water and nutrient availability, managing future increases in fire risk and the saturation of carbon stores in vegetation and soil over time.[159,160] Therefore, carbon forestry is a transition strategy to reduce emissions and limit warming this century before emissions from other parts of the economy can be reduced to effectively zero.

A key trade-off to consider on Australia's path to low emissions is the relative effort of decarbonising energy and industry versus the need to consider offsetting emissions through the land. Less sequestration in the land would be needed if emissions from energy, industry and agriculture could be reduced faster. Therefore, accelerating emissions reductions from other sectors would leave more land for farming or forestry in the future.

FIGURE 45: MOSAIC OF MIXED LAND USE



This figure shows an illustrative demonstration of a possible land use mix, with a segment of country divided into different capabilities. (Adapted from McKenzie and Grundy.[161])

159 Smith P, Davis SJ, Creutzig F, Fuss S, Minx J, Gabrielle B, Kato E, Jackson RB, Cowie A, Kriegler E (2016) Biophysical and economic limits to negative CO2 emissions. Nature Climate Change 6, 42

160 Smith LJ, Torn MS (2013) Ecological limits to terrestrial biological carbon dioxide removal. Climatic Change 118, 89–103

161 McKenzie NJ, Grundy MJ (2008) Guidelines for surveying soil and land resources. CSIRO

BOX 10: Maintaining the health of rural communities

The health of rural communities is essential to Australia. Their support and local knowledge are also vital to maintaining and leveraging Australia's competitive advantage in natural resources: its minerals, energy, world heritage landscapes and biodiverse ecosystems, as well as arable lands. Under *Slow Decline*, Australia falls behind on all important indicators of progress. Although under the *Outlook Vision* there would be enhanced prosperity and well-being in cities, rural Australia may miss out under a fractious global context, with agriculture under pressure to maintain profitability in the face of rising costs and more extreme weather events. However, this does not have to be the case. A cooperative global context with national and international actions aimed at limiting global warming to 2°C by 2100 could be a powerful economic force when combined with increased productivity that offers new opportunities to develop and sustain regional economies through environmental services. In addition, by promoting conservation stewardship, cultural, environmental and economic benefits may accrue to Aboriginal and Torres Strait Islander communities and result in sustainable land management outcomes more generally.[162]

4.4.3 RESTORE ECOSYSTEM HEALTH

The high agricultural productivity rates necessary for the *Outlook Vision* outcomes will not be possible without sustaining broader ecosystem health, particularly in the face of effects associated with a changing climate. Agriculture not only affects the environment but is also highly dependent on the quality of natural assets and the ecosystem services they provide for its productivity and profitability. In some cases it is the lack of financial incentives that prevent on-farm investment into practices that support long-term sustainable production under short-term financial pressures. The clearest threat to sustained productivity is the negative trajectory of soil health.[163] Several aspects of soil health will limit productivity, particularly long-term erosion, acidification, soil compaction and soil nutrient decline. Poor ecosystem and land management practices will lead to a deterioration of soil health. Agriculture is also dependant on access to a reliable supply of clean water, pollination services and shade and shelter provided through native vegetation, so a lack of investment in the environment can have wide ranging ramifications across the value chain.

Land degradation needs to be halted and, where possible, remediated to ensure the long-term viability of agriculture. This will not be possible in the absence of broader ecosystem health, which, in turn, depends on limiting global warming (in this scenario to less than 2°C by 2100).

The extent of additional land-based income derived from carbon farming, increased agricultural production and other environmental markets presents an opportunity to properly value the benefits for regional communities and create new forms of investment in ecosystem services and restoration, namely improving the condition of the nation's rivers, soils and biodiversity. By acknowledging the need for ecosystem restoration, a national consensus could be reached to instigate effective action for the long-term conservation of Australia's valuable natural assets. The inclusion of carbon income into farm value presents an opportunity to re-assess farm valuation approaches, encompassing a broader set of environmental outcomes that could be monetised, and that are inclusive of the trajectories of the underpinning drivers of farm production (such as soil health) that sustain farm production and income in the longer term.

162 Russell-Smith J, Whitehead PJ, Cooke PM, Yates CP (2009) Challenges and opportunities for fire management in fire-prone northern Australia. In Russell-Smith J, Whitehead PJ, Cooke PM, editors. Culture, ecology and economy of savanna fire management in northern Australia: rekindling the Wurrk tradition. CSIRO

163 Jackson WJ, Argent RM, Bax NJ, Clark GF, Coleman S, Cresswell ID, Emmerson KM, Evans K, Hibberd MF, Johnston EL, Keywood MD, Klekociuk A, Mackay R, Metcalfe D, Murphy H, Rankin A, Smith DC, Wienecke B (2017) Australia state of the environment 2016: overview. Independent report to the Australian Government Minister for the Environment and Energy, Australian Government Department of the Environment and Energy. Australian Government

4.5 Culture shift: Inclusive and resilient culture

The *Outlook Vision* and each of the shifts rely on Australia having the right culture, with inclusive civic and political institutions that foster greater engagement, curiosity, collaboration and solutions.

SELECTED *OUTLOOK VISION* MEASURES

Inclusive civic and political institutions that foster greater engagement, and curiosity to engage with new ideas and find solutions to national challenges.

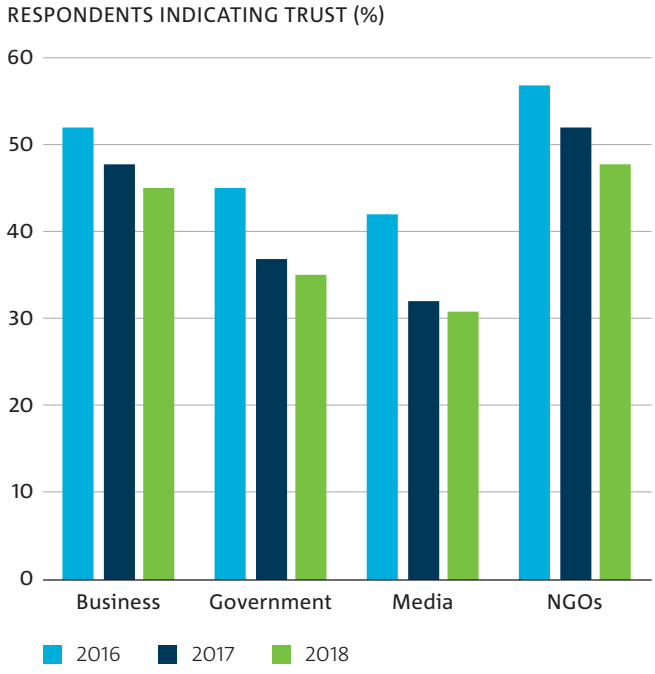
Strong incentives that support technology adoption, innovation and risk taking to increase Australia's resilience to shocks.

Long-term thinking that places greater value on the health of Australia's natural environment and the benefits that can be gained through the improved wellbeing of all Australians.

THREE LEVERS THAT SUPPORT AN INCLUSIVE AND RESILIENT CULTURE INCLUDE:

- **Reforge institutional trust:** earned respect for our business, political and social institutions, that counters recent declines in trust and creates a licence to act (Figure 46).
- **Encourage healthy risk taking:** a healthy culture of risk taking and curiosity to support innovation in all parts of the Australian economy and community.
- **Broaden decision making:** a recognition of the importance of social and environmental outcomes in government and industry decision making processes.

FIGURE 46: TRUST IN AUSTRALIAN INSTITUTIONS[11]



This figure shows the percentage of respondents that indicated they had trust in an institution to do what is right. A list of institutions was supplied and, for each one, general population respondents were asked to indicate how much they trusted that institution to do what is right on a nine-point scale, where a score of 1 meant that respondents 'do not trust them at all' and a score of 9 meant that respondents 'trust them a great deal'.

4.5.1 REFORGE INSTITUTIONAL TRUST

Trust matters. It enables businesses to leverage their relationships with employees, stakeholders, regulators, customers and clients to invest and innovate, and it empowers governments to make necessary changes to policy and programs. Trust is also vital in responding to crises.

Reflecting on the 1980s, institutional trust can be appreciated**.** The recovery in productivity growth experienced in the mid-1980s was driven by a bipartisan consensus on broad economic reform that spanned both major parties, big business and the union movement. The bipartisan consensus also spanned extensive deregulation or changes to public entities, service markets, product markets, financial markets, labour markets, trade, taxation, welfare and superannuation.[50] At the time, the reforms were remarkable for having been enacted in the face of popular opposition. Australia had 'leaders who were willing to expend short-term political capital in pursuit of the longer-term benefits of reform'.[50]

Today, for many complex reasons, trust has weakened. The 2018 international Edelman Trust Barometer highlighted a decline in trust among the general population in business, NGOs, government and the media since the previous year, a challenge shared by many Western democracies.[11] Although the recent 2019 Edelman survey shows a slight rebound in trust compared with 2018, trust remains a significant issue for Australian institutions.

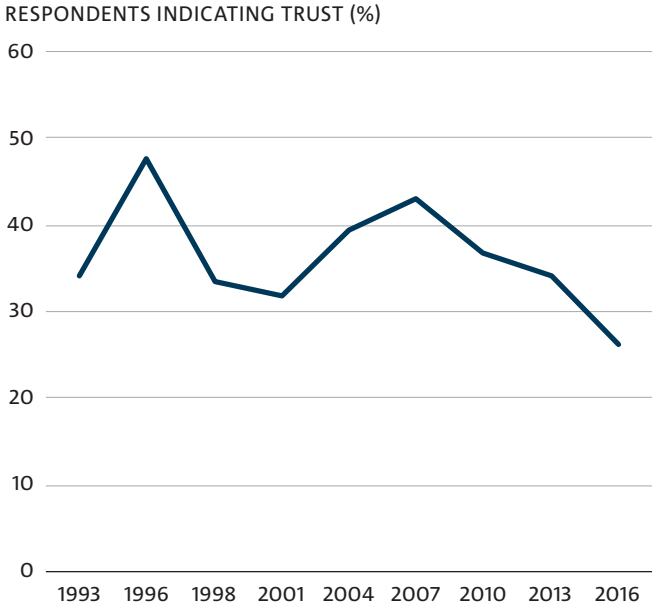
Levels of trust in business have been largely stagnant, hovering between distrust and a neutral attitude (with between 44% and 52% of respondents to the Edelman trust survey indicating trust). The 2018 Edelman Trust survey highlighted a decline in trust across all 15 sectors surveyed, with the Australian energy and financial services sectors ranked most poorly (registering below 50% trust).[11] CEO credibility is also low; when asked, only 39% of respondents rated CEOs as very or extremely credible. The survey also highlighted that respondents considered building trust as a top priority for CEOs. At the same time, citizens expect more from business leaders today, with 65% of respondents to the Edelman Trust survey saying that CEOs should take the lead on change rather than waiting for governments to impose it.[164] Australian businesses have started to sense this change in expectations, as reflected by the recent participation of over 660 corporations in the same-sex marriage campaign.[165]

164 Harrington M (2017) Survey: people's trust has declined in business, media, government, and NGOs. Harvard Business Review

165 Gray J (2018) Alan Joyce, Twiggy Forrest and Mike Cannon-Brookes won't be last activist CEOs. The Australian Financial Review

In Australia, trust in government fares worse. As measured by the Australian National University's Australian Election Study after each federal election since 1993, trust in government continues to slide, showing a decline of 16 percentage points to just 26% in 2016 (Figure 47).[10] NGOs are not immune from this trend, suffering a 9 percentage point decline over the last two years (Figure 46); however with 48% of respondents expressing trust, NGOs remain more trusted than business, government and the media. Given their relatively higher trust, expertise and position of independence, NGOs and their volunteers have an opportunity to provide just services and inform public debate.[166]

FIGURE 47: TRUST IN GOVERNMENT[10]



This figure shows the percentage of respondents indicating that 'People in government can be trusted'. Data were collated from Australian Election Studies,[10] all of which are national, post-election self-completion surveys with the sample drawn randomly from the electoral register.

There is no silver bullet to recovering trust in these institutions, but it is clear that further effort and research are needed. With regard to trust in business, respondents to the Edelman Trust survey identified fostering prosperity for workers, taking care of people and fairness and equity as key areas for trust-building.[11] Trust can also be restored in businesses by pursuing a more inclusive strategic direction, for example by incorporating employees and their thoughts into how to direct and grow businesses.[164] Respondents in a 2018 inaugural trust study by Deloitte flagged honesty, transparency and promise-keeping as vital to trust restoration in the banks.[36]

In terms of trust in government and politicians, it has been proposed that trust can be rebuilt by addressing policy over-promising, the perceived unrepresentative nature of politicians who come from 'increasingly narrow backgrounds', the perception that politicians favour vested interests and the range of benefits that politicians receive.[37]

Overcoming entrenched adversarial cultures will help parliaments and executives attain a more bipartisan and effective focus on longer-term needs and aspirations. Changes will also be needed in the media and society. A greater understanding of how and why social and political institutions operate will assist this effort, as will the exploration and communication of how participating in them is essential for a healthy economy and society.

166 Maddison S, Carson A (2017) Civil voices: researching not-for-profit advocacy. University of Melbourne

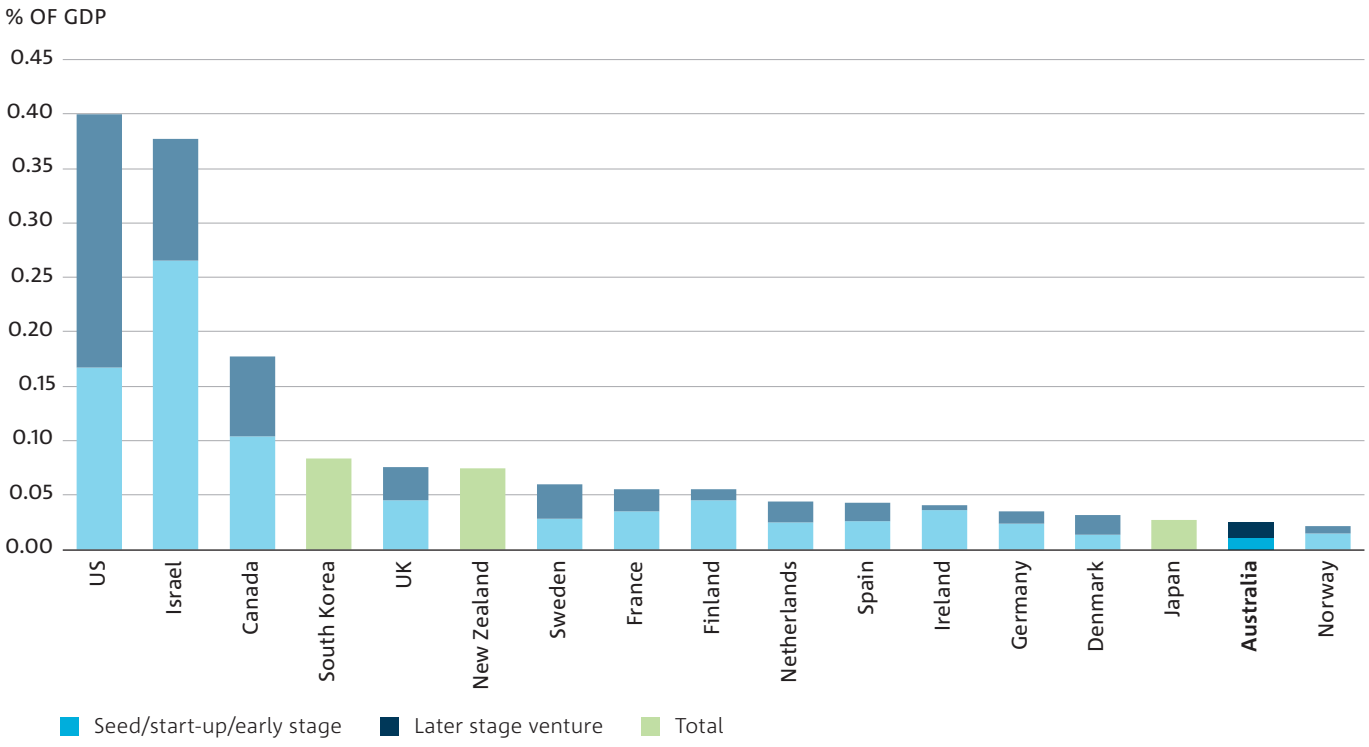
4.5.2 ENCOURAGE HEALTHY RISK-TAKING

Along with developing trust in decision-making institutions, the *Outlook Vision* depends on the existence of a healthier risk-taking culture in all parts of the Australian economy and community. The risks that need taking are those based on an awareness of the need to act, a curiosity for potential answers and an objective consideration of the facts, and only then risking an investment or decision for something that may be unfamiliar but is, on balance, needed. Only then will Australia be able to invest in the technology needed for productivity, in the emerging sectors needed for resilience, in the technology needed for affordable, reliable low-emission energy and in the sources of future land-based income.

In earlier sections, attention was drawn to the relatively low levels of technology adoption in many Australian sectors. More data points to the relative lack of risk culture, entrepreneurship and risk capital in Australia, all of which explain that lagging adoption. For example, 44% of global companies with the largest R&D spends have a 'high performance innovation culture' compared with only 16% of Australian businesses.[167] Australia also ranks very low in international comparisons of venture capital investment (Figure 48), and Australia is ranked 22nd overall in the Global Entrepreneurial Index, with 41.4% of respondents feeling held back by a fear of failure.[168]

Respondents in the Global Entrepreneurial Index survey stressed the actions Australia may need to take to improve its innovation and risk culture: they pointed to entrepreneurial programs that bring businesses together with young and experienced entrepreneurs, encourage experimentation by a firm's workforce and link formal studies to industry and digital technology.[169] These programs also insist on the value of learning from failure in innovation, and the participation of gender and culturally diverse groups.

FIGURE 48: VENTURE CAPITAL INVESTMENTS[168]



This figure shows venture capital investments as a percentage of GDP across a range of developed countries in 2017, or latest available year.

167 Department of Industry, Innovation and Science, Office of the Chief Economist (2015) Australian Innovation System Report 2015. Australian Government
168 Global Entrepreneurship Research Association (GERA) (2018) Global Entrepreneurship Monitor: Global Report 2017/18. GERA
169 OECD (2018) Entrepreneurship at a Glance 2018 Highlights. OECD

4.5.3 BROADEN DECISION MAKING

The *Outlook Vision* and each of the shifts highlight the importance for social and environmental outcomes to be considered in decision-making processes for government, industry and civil society organisations. Incorporating these considerations into decision-making creates an opportunity to deliver significant commercial value for the private sector and reduce the burden on government and civil society in the process. Failure to weigh these considerations can lead to greater costs for all sectors, as well as an erosion of trust and confidence in institutions from communities more broadly. Social and environmental considerations are deeply integrated into the shifts outlined in this report. For example, the productivity needed in the industry shift depends on the quality of human capital, which is constrained, in part, by the quality of Australia's cities. The production and use of energy is influenced by local and global action on climate change, which in turn, impacts ecosystem health, the condition of Australia's soils and agricultural productivity. Incorporating social and environmental considerations is vital for realising the *Outlook Vision* and will re-define the roles of organisations across each sector.

The private sector has a significant business opportunity in responding to these shifts at scale, leveraging its core assets and expertise. One approach that enables companies to conceive of their role differently is through the lens of shared value – a way for companies to strengthen their competitive positioning by accessing new markets, creating new products, driving operational efficiencies or investing in local clusters, while also addressing social and environmental challenges.[170]

The scale of the opportunity for the private sector is vast. The United Nations (UN) Sustainable Development Goals (SDGs)[171] provide a "blueprint to achieve a better and more sustainable future for all". A report by the Business & Sustainable Development Commission, which had input from global leaders from business, finance, civil society, labour, and international organisations, estimated that achieving the SDGs could open up US$12 trillion of market opportunities.

The opportunities identified span food and agriculture, cities, energy and materials, and health and well-being, similar to the opportunities identified in the Industry Shift (see Section 4.1).[172] Among other considerations, the report also highlights the potential gains for companies that focus on inclusion by incorporating the SDGs into business strategy, with particular focus on the influence companies can have on achieving gender equality. The question for companies is how to embed social and environmental considerations into corporate strategy in order to capture this opportunity.

Another opportunity for companies is the improvement of employee wellbeing. Mental illness for example can have wide ranging effects on productivity and business outcomes. These effects include an increase in absenteeism and presenteeism (i.e. having lower productivity when at work). Absence rates can be as much as 5% higher for those reporting poor mental health.[173] When also factoring in compensation claims, it is estimated that the economic impact on Australian workplaces of mental health conditions is approximately $11 billion per year.[174] Initiatives that reduce job stress and incorporate prevention, early intervention and rehabilitation have the potential to reduce the individual effects of mental illness as well as lift overall productivity and financial performance. Companies that do more than their peers to address these challenges will improve their competitive positioning within the market.

Just as the opportunity is significant, so too is the risk if these social and environmental considerations facing government, industry and civil society are ignored. A report from the Economics of Land Degradation Initiative estimates that land degradation could be costing the world between US$6.3 trillion and $10.6 trillion every year, equivalent to 10–17% of global gross domestic product.[175] The report estimates the cost of this environmental destruction not only from lost agricultural production and diminished livelihoods, but also from the lost value of ecosystem services, including water filtration, erosion prevention, nutrient cycling and the provision of clean air.

170 Porter ME, Kramer MR (2011). Creating shared value. Harvard Business Review 89, no. 1-2: 62–77

171 United Nations (UN) (2015) Transforming our World: The 2030 Agenda for Sustainable Development. UN

172 Business & Sustainable Development Commission (2017) Better Business, Better World. Business & Sustainable Development Commission

173 Bubonya M, Cobb-Clark DA, Wooden M (2017) Mental health and productivity at work: Does what you do matter? Labour Economics 46, 150-165

174 PWC (2014) Creating a mentally healthy workplace: Return on investment analysis. PWC

175 ELD Initiative (2015). The value of land: Prosperous lands and positive rewards through sustainable land management. Available from www.eld-initiative.org

Addressing this risk and capturing the opportunities created by sustainable land management requires significant change to the current flow of investment and deployment of resources, and will require a different understanding of the roles and responsibilities of all organisations, particularly from the private sector.[176]

Beyond the missed opportunity and potential cost, failure to consider social and environmental outcomes in decision making can create risks or lead to incomplete decisions and the erosion of trust from communities and stakeholders. Recent work by the Task Force on Climate-related Financial Disclosures highlights the financial risks for companies associated with the impact of climate change.[177] This work has prompted a growing movement for companies to consider and disclose these climate-related financial risks on their business.

Another extension of this type of risk is the concept of a 'social licence to operate' in the mining industry, which demonstrates the importance of incorporating social and environmental considerations to preserve the support of local communities. A company's social licence can be managed by pro-actively establishing strong relationships with the community, monitoring and managing environmental and social risks, seeking to address local problems and building a sense of joint ownership and commitment.[178] While this approach provides positive long-term social and environmental outcomes, it also helps manage a key risk, as failure to earn and maintain community support and approval has been found to reduce the market value of a project by up to 70%.[179]

176 Mohieldin M, Klimenko S (2018) How the private-sector can help fund the Sustainable Development Goals. World Economic Forum in collaboration with Project Syndicate

177 Task Force on Climate-related Financial Disclosures (2017). Recommendations of the Task Force on Climate-Related Financial Disclosures. Financial Stability Board

178 Littleboy, A. (2015). Social capital in the life-of-mine, The AusIMM Bulletin – October 2015

179 Tarnopolskaya, T., Littleboy, A., (2015). Towards Dynamic Financial Valuation of Social Licence to Operate under Uncertainty, 21st International Congress on Modelling and Simulation, Gold Coast, Australia, 2015

For business, government and civil society to incorporate social and environmental considerations into decision-making effectively, there must be several enabling factors:

Better use of social and environmental data and measurement

In addition to recognising social and environmental outcomes and value, effective decision making requires performance metrics and accessible datasets to help inform decisions. Various measures already exist at a national level, such as the Scanlon Social Cohesion Index[39] referred to earlier in this report (see Section 2.6). However, metrics and datasets are required at different levels of granularity, from a national and industry scale all the way down to a regional and enterprise scale to ensure they are relevant to the scale at which decision making is made. Although digital technologies are capable of enabling the data platforms needed for the future, further work and research is required. Beyond collecting and integrating what is often siloed data and accounting for data privacy and ownership questions, there is a need to understand what metrics are required and how business, industry and regional communities could use such data in their decision-making processes.

An example of this multi-scale approach is outlined in the recent National Strategy for Environmental-Economic Accounting by the Australian Government that should support public sector and business decision making at all levels and across all sectors.[180] This strategy recognises that for the business community to incorporate social and environmental outcomes into decision making, there needs to be an understanding of the value that is created from addressing these issues. While this suggestion may seem difficult to some, particularly in light of the earlier discussion of trust, there is growing understanding of the relationship between social and environmental outcomes and financial performance in terms of both capturing opportunities and mitigating risks.

Promotion of innovative business solutions to social and environmental challenges

There are increasing examples of companies driving innovation to respond to social and environmental challenges profitably. One example from South African insurer Discovery Limited shows the commercial gain realised by the company by using incentives focused on health promotion for its customers. Discovery's approach harnesses rewards, discounts and data analytics to encourage healthier customer behaviours. This model has lowered morbidity and mortality rates while leading to lower claims costs for the company.[181]

Another example is the concept of "circular economy" which captures a range of business opportunities that can be created when taking on responsibility for whole-of-life impacts. One aspect of the circular economy explores recycling and re-use in order to leverage what is often considered waste for entirely new growth opportunities. The value of such activities has been proven in many industries throughout history, such as the transformation over the last few decades of considering whey proteins (a co-product in cheese-making) as waste to being prized as raw material in the dairy industry,[182] particularly in the growing proteins market in Asia Pacific, which was valued at almost US$2.2 billion in 2014.[183] Recent overseas studies, as well as national and global circular economy strategies and investment from major global businesses are helping support a transition towards a circular economy.[184] This includes investment from groups such as Closed Loop Partners. A collaborative cross-sector effort that involves some of the largest consumer organisations in the US, this program seeks to support recycling infrastructure in the US to reduce waste and commercialise waste streams originating from consumer products. Through investment into advanced recycling technologies, this program seeks to recycle and re-introduce waste as a product directly into major corporate supply chains. The Closed Loop Partners fund also supports investments into recycling facilities and infrastructure for local councils, including a program in Memphis, Tennessee to increase the number of single stream recycling carts available to households across the city in 2016. The partnership includes investors from organisations such as Amazon, 3M, Coca-Cola, Unilever and the Walmart Foundation[185] and promotes collaboration between government and the private sector to improve recycling outcomes in communities.

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Re-consideration of the use of capital and business structures

There is a growing trend for investors to make decisions on the basis of social, environmental and financial returns simultaneously. The growth of Responsible Investment Association Australasia (RIAA), a network of over 220 members managing more than $9 trillion, is a good example of this trend. The goal of the RIAA is to ensure capital is invested more responsibly to underpin strong investment returns with the delivery of a healthier economy, society and environment. Continuing an upward trajectory, the latest RIAA report shows that 55.5% of assets professionally managed fall into the responsible investment category.[186]

This trend also signals the allocation of investment capital to companies that are doing more to factor social and environmental considerations into decision-making. This has been neatly summarised by Larry Fink, the CEO of BlackRock Inc., one of the world largest global investment management corporations with over $8.8 trillion of assets under management.[187] In his 2018 annual letter to CEOs, Fink emphasised that every company must not only deliver financial performance but also make a positive contribution to society, benefiting shareholders, employees, customers and the communities in which it operates.[188] Fink implored companies to ask what role they play in the community, how they are managing their environmental impact, if they are creating a diverse workforce and whether they are providing the opportunities necessary for the transition into an increasingly automated workplace.

There has also been a recent emergence of "for-purpose" corporate enterprises. These seek to achieve both financial and non-financial returns, as exemplified by the proliferation of certified B Corps, which depend less on self-reporting and more on strict auditing. Approved companies are required to 'balance profit and purpose' by 'consider[ing] the impact of their decisions on their workers, customers, suppliers, community, and the environment'.[189] There are currently over 200 such registered certified B Corps in Australia and New Zealand.[190]

Greater collaboration across sectors

By engaging in more collaborative efforts across sector lines, organisations from across the spectrum will be able to understand and respond to social and environmental challenges more effectively. The complexity of the challenges facing society – like climate change or ensuring affordable housing for all – make it impossible for one single organisation (or sector) to address them in a meaningful way. Through collaboration, the impact of social and environmental considerations becomes clearer as different organisations gain insight from the experience of their partners.

The Department of Foreign Affairs and Trade (DFAT) has incorporated cross-sector collaboration into its revised approach to aid and development in the Australia-Pacific region. Through its Business Partnerships Platform, DFAT is encouraging collaboration between Australian companies, government and community organisations to discover market-based solutions to development challenges in the region.[191]

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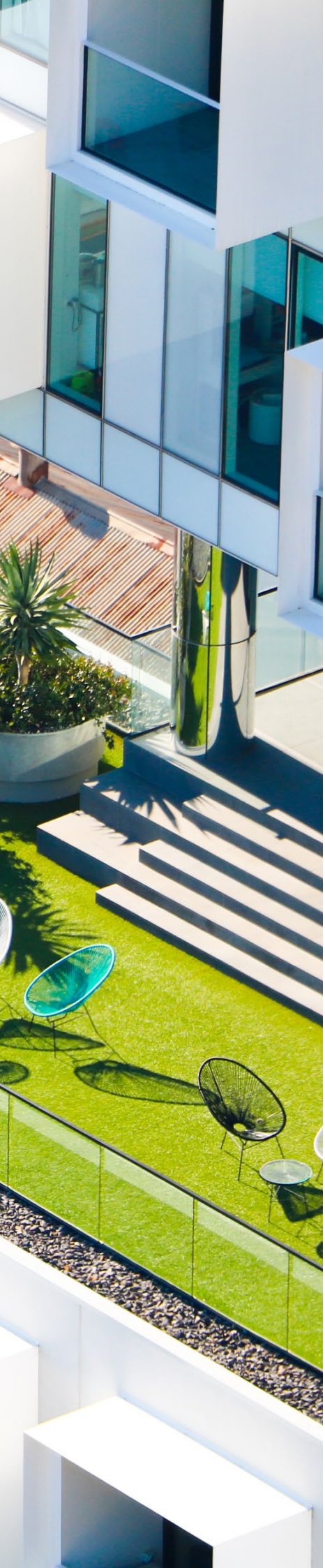


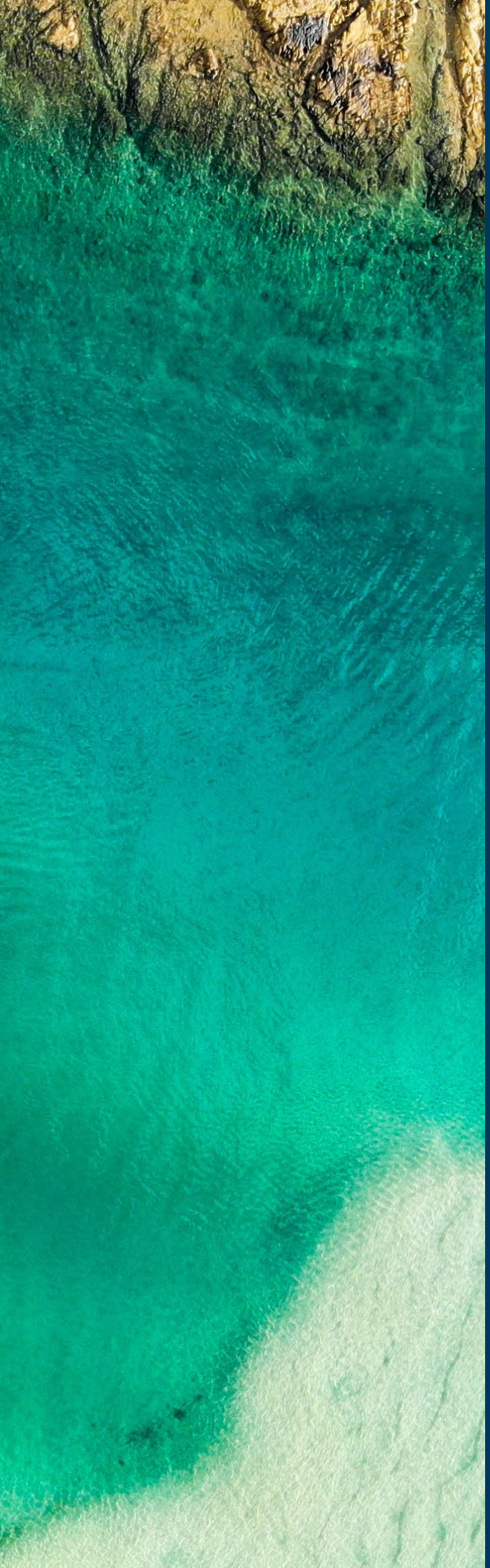
5 Conclusion and the need for action

The *Outlook Vision* assumes that Australia can build on past successes by making positive choices that convert global and national trends and challenges into opportunities for future economic, environmental and social well-being. For the most part, these outcomes are dependent on national choices. However, as the global outlook is uncertain, Australia should be adaptable and prepared to deal with the full range of possible global outlooks.

Achieving these positive outcomes is within Australia's grasp, but it will require significant action and long-term thinking across five key shifts: industry, urban, energy, land and culture. Although many of the shifts will take decades to play out, this should not be construed as a reason to delay action. On the contrary, many longer-term impacts, such as the effect of climate change, are already underway and are heavily dependent on shorter-term actions. It is time to prepare and place Australia on the right trajectory.

Importantly, these shifts require concerted effort involving a range of public and private organisations. The expertise and thinking needed to achieve the outcomes described in this report extend beyond any single organisation or group.

The Australian National Outlook 2019 report does not address every challenge Australia has, nor does it offer all the solutions. By and large, the report is without presumption about the particular or specific policies which need to be implemented to meet the challenges outlined. Rather, the Australian National Outlook 2019 aims to expand future thinking and generate discussion, communicate trade-offs between different choices and guide planning. It aims to build a platform for change for those who wish to realise the positive future available.



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For additional detail, please refer to the Australian National Outlook 2019: Technical Report.

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