

An Assessment of Australia's Future Infrastructure Needs

The Australian Infrastructure Audit 2019



Challenges and
opportunities
for Australia's
infrastructure
services

Infrastructure Australia is an independent statutory body that is the key source of research and advice for governments, industry and the community on nationally significant infrastructure needs.

It leads reform on key issues including means of financing, delivering and operating infrastructure and how to better plan and utilise infrastructure networks.

Infrastructure Australia has responsibility to strategically audit Australia's nationally significant infrastructure, and develop 15 year rolling infrastructure plans that specify national and state level priorities.

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Burrungkuy (Nourlangie), Kakadu National Park

Acknowledgement of Country

Infrastructure Australia acknowledges the Traditional Custodians of Australia, and pays respect to their Elders past, present and emerging. We pay respect to their continuing connection to land, and the continuation of their cultural, spiritual and educational practices.

In preparing for the future of our infrastructure, we acknowledge the importance of looking beyond the immediate past to learn from Aboriginal and Torres Strait Islander's unique history of land management and settlement, art, culture and society that began over 65,000 years ago.

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i. Chair's foreword

Infrastructure is fundamental to our quality of life. It connects us to jobs, education and other opportunities. It allows us to travel safely home to our families at the end of each day and enables us to keep in touch with friends near and far. It provides us with the essential services we rely on – from energy, water, and telecommunications, to social infrastructure such as hospitals, schools and parks, and access to goods, such as fresh food, that most Australians could not imagine living without.

Most of our networks work well, and support our lives every day in ways we have grown to take for granted. But infrastructure is only as good as the services it delivers to users. When it comes to infrastructure, the community has told us what matters most – access, quality and cost.

Too often, our infrastructure doesn't meet these needs. Congestion, crowding, rising bills, outages and declining service standards can undermine our confidence in the infrastructure we use. These are clear signals that our infrastructure needs to work harder to support Australia into the future.

Infrastructure Australia has a mandate to drive better infrastructure outcomes for all Australians. As the nation's independent infrastructure advisor, it is our job to champion the 'big picture' view of Australia's infrastructure needs – across sectors and across jurisdictions. This involves developing a national evidence base to guide infrastructure decision-making, and focus attention on the investments and reforms that will improve both our living standards and national productivity.

The 2019 Audit covers transport, energy, water, telecommunications and – for the first time – social infrastructure, and looks at the major challenges and opportunities facing Australia's infrastructure over the next 15 years and beyond. We have presented our findings in terms that matter to users, by focusing on outcomes for them. Our hope is that this enhanced focus on users, and the role infrastructure can play in improving their quality of life, helps to drive better decisions that are rooted in the long-term interests of Australians.

Since the 2015 Audit, Australia's infrastructure has witnessed positive progress. There has been a material increase in the level of investment, and governments across the board have initiated reforms aimed at enhancing the performance of infrastructure. However, the clear message from across the sectors is that more must be done if we are to maintain, let alone enhance, our quality of life and economic efficiency.

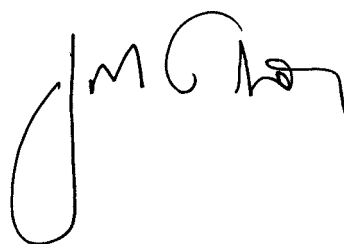
Australia's infrastructure faces a range of challenges– vast distances, extreme weather, increasing maintenance backlogs and rapidly growing cities. While increased levels of public and private investment are welcome, we still rank below the OECD average for infrastructure investment. The world is also rapidly changing, and at a faster rate than we've experienced in the past. This brings immense opportunities to further improve the lives of all Australians but also poses challenges regarding how we plan, deliver and operate our infrastructure.

In this context, sustained reform and increasing investment is still required.

This is Infrastructure Australia's second national Audit. Like its predecessor, in 2015, the 2019 Audit and its findings will inform the recommendations in our next major pieces of work – initiatives and projects in the annual *Infrastructure Priority List* and reforms in the *Australian Infrastructure Plan*, which is due for release in 2021. Together with these two documents, the Audit is intended to guide the next wave of infrastructure reform in Australia.

The challenges and opportunities identified in this Audit are just the starting point. We invite submissions to help build on the findings of the Audit. I invite you all to engage with the issues and findings of this Audit to ensure our advice is informed by a diversity of evidence and opinions about the role infrastructure should play for decades to come.

Our hope is that this provides the foundation for the Australian Government, as well as other governments, industry and the community, to deliver a clear and positive agenda for Australia.



Julieanne Alroe
Chair, Infrastructure Australia



ii. Key messages

The findings of the *Australian Infrastructure Audit* are broad in scope, covering the full range of sectors, modes and geographies that are impacted by Australia's infrastructure. However, across the document there are several key messages and a set of common themes regarding the outcomes for users and the impacts on communities.

Outcomes for users

Access: Access to choice in infrastructure services has improved since the 2015 Audit, largely due to new technology. While access to choice is strongest in fast-growing cities, it is weaker in other areas, and for people from lower socio-economic and diverse backgrounds.

Quality: The quality of infrastructure services is high for most Australians in urban areas, however population growth is impacting some services. Low density areas, emerging industries and lower socio-economic groups' needs are not met.

Cost: Average household infrastructure costs have grown in real terms, but decreased as a proportion of household incomes. However, these costs disproportionately impact low-income households.

Impacts on communities

Fast-growing cities: Infrastructure in our four largest cities is failing to keep pace with rapid population growth, particularly on the urban fringe.

Smaller cities and regional centres: These areas are growing as service hubs for their neighbouring regions, including supporting growth as satellites of fast-growing cities.

Small towns, rural communities and remote areas: The quality of infrastructure services for people living in remote communities does not meet the standards Australians expect.

Developing regions and northern Australia: Infrastructure can catalyse quality of life and productivity by improving connectivity and efficiency.

1. **Since the last Audit, governments and industry have made important progress to promote reform, improve planning and invest in infrastructure gaps.** Since 2015 over \$123 billion of work has commenced,¹ with a committed forward pipeline of over \$200 billion.²
2. **However, changing and growing demand, and a mounting maintenance backlog, mean a new wave of reform and investment is necessary to ensure quality of life and economic productivity are enhanced over the next 15 years.** By 2034, Australia's population is projected to grow by 23.7% to reach 31.4 million,³ adding to infrastructure demand, while existing infrastructure struggles under maintenance backlogs and the condition of many assets is unknown.
3. **Users are often not at the centre of infrastructure planning and decision making for Australia's future, however communities are increasingly demanding greater transparency and service choice.** Engagement with communities is critical, with 80% of Australians indicating it is important that government considers the views of the community when planning or investing in major infrastructure.⁴
4. **Constant and rapid change is creating challenges for the way we plan, deliver and operate infrastructure.** For example, the sharing economy has rapidly grown across infrastructure sectors, particularly the transport sector where the use of ridesharing services have more than tripled between 2015 and 2018.⁵
5. **Growing social, economic and environmental interdependencies have added both complexity and opportunity to the planning, delivery and operation of our infrastructure.** For example, the increased uptake of electric vehicles will have implications for the energy sector. By 2040 40% of our vehicles are likely to be electric, and these vehicles could have the potential to store electricity to a similar capacity as the proposed Snowy 2.0 scheme.⁶
6. **Infrastructure is facilitating structural changes to the Australian economy, as we shift away from traditional industries, such as manufacturing, towards knowledge and service-based industries.** In 2017-18 economic activity in Sydney and Melbourne together accounted for 52.8% of national growth.⁷ To support this activity the New South Wales and Victorian governments have a committed forward pipeline of transport infrastructure investment totalling over \$78 billion in these cities.⁸
7. **Australia's national productivity and global competitiveness rely on efficient infrastructure networks, however we are falling behind international competitors.** Australia currently ranks 18th in the world for ease of doing business, having dropped over the past decade from 9th in 2008.⁹
8. **Infrastructure is the most significant contributor to Australia's greenhouse gas emissions, however progress to reduce emissions is inconsistent and policy directions remain uncertain.** For example, while electricity emissions have decreased by around 3% since 2015, emissions in the transport sector have increased by almost 9%.¹⁰
9. **New technologies are enabling substantial improvements to user experience and quality of life outcomes, but these benefits are not being shared by all Australians.** The digital inclusivity of our lowest income quintile is one-third below the national average.¹¹
10. **Population growth impacts are being felt in fast-growing cities as infrastructure is placed under pressure, including congestion on our roads and crowding on public transport.** 77% of population growth over the coming 15 years is projected to occur in our fast-growing cities,¹² leading to pressure including road congestion growing by \$18.9 billion to \$38.8 billion in 2031.¹³
11. **People live in diverse areas across Australia, from fast-growing cities to remote areas, meaning infrastructure accessibility, quality and cost differ for users in different places.** For example, the National Broadband Network (nbn) is able to deliver internet speeds via Fibre to the Premises of over 100 Mbps to some residents in urban areas,¹⁴ whereas some remote areas rely on satellite services that can only deliver speeds of up to 25 Mbps.¹⁵
12. **Policy uncertainty and poor coordination has affected investment in the energy sector and delayed an effective response to rising energy prices, impacting energy reliability and increasing community anxiety regarding climate change.** Over the past decade, the unit price of electricity has risen in real terms by 56%,¹⁶ while retail gas for households has risen by 45% over the same period.¹⁷
13. **Some infrastructure services will continue to require government subsidies, however these are not transparent and often poorly targeted to those in need.** There are 315 community service obligations for infrastructure, 39% of which are not transparent.¹⁸
14. **New data is being generated in real-time on the performance and use of our infrastructure, enabling improved decision making by users and operators.** Road agencies are providing live traffic data on smartphones, in car devices and roadside signage, while transport operators are using smartphone data and third-party apps to show train carriage capacity and to direct waiting customers to empty carriages



iii. Executive summary

1. A future of uncertainty

Australia, perennially labelled the ‘Lucky Country’, stands in a position of strength. However, looking to the future, we face an unprecedented period of uncertainty.

The compounding issues of a changing climate, the re-ordering of the world economy, and increasing political polarisation are reshaping global institutions and norms. Closer to home, our population is growing and changing, the structure of the economy is shifting, our communities and environment are experiencing weather extremes, and rapid technology change is fundamentally reshaping our day-to-day lives.

As a result, Australia finds itself at a unique point in its history with significant implications for how we plan for our future infrastructure.

Infrastructure is central to our quality of life. But looking to the future, user needs are evolving and it is very likely, in coming decades, our infrastructure will look very different to today.

We need to evolve the way we plan for Australia’s infrastructure to embrace this uncertainty. Historically, infrastructure planning has sought to predict future conditions and then provide infrastructure to meet anticipated demand. Today, we require a more robust approach.

Rather than projecting forward the status quo, our infrastructure planning should set an ambitious vision for the country, anticipate and adapt to change, manage risk, and deliver infrastructure that works towards – rather than against – the current and future needs of Australians.

The time is right to reconsider how we deliver infrastructure, and how we can adapt existing networks to our changing user needs. The *Australian Infrastructure Audit* is the starting point for this process.

The context of uncertainty has formed the foundational principle for Infrastructure Australia in developing the Audit. It has provided the lens through which we have assessed the current capacity of our existing infrastructure networks and assets, and identified the challenges and opportunities sectors face in the coming 15 years.

What has changed since the 2015 Audit

Infrastructure Australia's first Audit, released in 2015, was the first national picture of our infrastructure and the challenges it faced.

Since the release of the 2015 Audit and the first *Australian Infrastructure Plan* in 2016, Australia has witnessed a number of positive shifts in the way we plan, deliver and operate our infrastructure.

Infrastructure investment across key economic sectors, especially transport, has showed signs of an upward trend since early 2016.

At the same time, governments are increasingly integrating infrastructure and land-use planning. A number of strategically significant transport corridors have been preserved. Regulatory changes have enabled new service delivery models in transport, energy and telecommunications. New technologies are improving user experience across all sectors, from telehealth to smart water meters.

In other areas, ongoing challenges remain and new issues have emerged:

- Population growth has become a major point of contention in infrastructure debates. In our largest cities, ageing assets have been put under growing strain, with rising road congestion, crowding on public transport and growing demands on social infrastructure, such as health, education and green space.
- Energy affordability has also deteriorated over recent years. A steep rise in network costs has driven energy bills 35% higher over the past decade, and up by 56% per unit of electricity consumed in real terms.¹⁹
- In telecommunications, the nbn rollout continues to face challenges. In the 4.8 million households in which it has activated,²⁰ services have not met the expectations of many users.
- In the water sector, the past four years have seen mixed results. Many metropolitan utilities are increasing the sustainability and quality of their services through innovation, supporting the liveability of our cities. But many regional areas are suffering from growing water security fears as large parts of the country are in drought.

The objectives of this Audit

The role of this Audit is not to identify solutions. Before arriving at solutions, it is important to have a clear understanding of the problems we are seeking to solve. To do this, the Audit identifies issues, gaps, problems and untapped potential in the form of:



Challenges: Where a change in how we deliver infrastructure is required to avoid future costs or erosion of our quality of life or productivity.



Opportunities: Where infrastructure could unlock future growth and development, and improve quality of life or productivity beyond the status quo.

This distinction between challenges and opportunities is important to ensure infrastructure planners and proponents identify and progress infrastructure solutions that not only keep pace with community aspirations and demands, but create the potential to unlock step changes into the future.

In developing this Audit, our aim has been to engage both the users and providers of infrastructure. To achieve this, this document is drafted to be relevant and easily accessible to a broad audience.

This means it is not a conventional audit. Instead of providing a comprehensive assessment of the quality and capacity of individual infrastructure assets or networks, we seek to:

- Provide information about the most significant issues for each sector
- Guide and frame discussions using new evidence and the significant body of research undertaken by others
- Create a platform for the further analysis needed to support future decisions.

The approach of this Audit

In response to the current setting of uncertainty, Infrastructure Australia has taken a new approach to the development of the 2019 Audit, informed by strategic foresight methods.

Strategic Foresight is a new field of research that aims to understand the future in a way that does not simply extrapolate past trends forward.²¹ Instead, foresight methods use available knowledge and forecasting tools to understand plausible future events and, based on a balanced view of the different futures that may occur, enable robust decision making and investment.

Infrastructure Australia has applied this thinking to the development of a three-stage methodology:

1. **Horizon Scanning:** The starting point for Infrastructure Australia in undertaking this Audit was to understand the national and global forces that are likely to shape Australia over the coming decades. These trends focus on shifts that are likely to transform how we live, and consequently what we need from infrastructure.
2. **Interpretation and analysis:** The next step was to apply these trends to the sectors of transport, water, energy, telecommunications and social infrastructure, to understand the likely future impacts and needs of these sectors. To do this, we have sought to understand future infrastructure needs for users and places.
 - The Audit puts users at the centre of infrastructure issues, and focuses on the key user outcomes of access, quality and cost in order to understand how infrastructure can do more to meet user needs.
 - We looked to understand impacts on community types, rather than conventional geographic boundaries, by adopting four broad settlement categories: fast-growing cities, smaller cities and regional centres, small towns, rural communities and remote areas, as well as developing regions and northern Australia.
3. **Identifying challenges and opportunities:** Based on this analysis, the Audit has identified a set of sector-based and cross-sectoral challenges and opportunities. For each challenge or opportunity, the Audit provides an estimate of when each will impact infrastructure services and users if no action is taken.

To support this analysis, Infrastructure Australia has drawn evidence from the substantial knowledge and expertise among government agencies and industry representatives who plan, build, operate and maintain our assets and networks.

Where clear and reliable evidence exists, our aim has been to build on this work, rather than compete with it. We have commissioned a range of supporting papers to supplement the Audit evidence base. These are published on our website as is this document.

The structure of the document

The Audit is divided into four sections:

1. **Future Trends:** 2. *Future Trends* identifies the future national and global trends impacting Australia, and our infrastructure, over the next 15 years and beyond.
2. **Cross-sectoral chapters:** 3. *Infrastructure services for users*, and 4. *Industry efficiency, capacity and capability*, bring together the challenges and opportunities that are common across all sectors.
3. **Sector-based chapters:** 5. *Transport*, 6. *Social Infrastructure*, 7. *Energy*, 8. *Telecommunications*, and 9. *Water*, individually identify the challenges and opportunities relevant to each infrastructure type.
4. **Next steps:** 10. *Next Steps* provides information on how to provide feedback on the Audit and contribute to the development of the forthcoming *Australian Infrastructure Plan* and the *Infrastructure Priority List*.

The remainder of the Executive Summary provides a detailed summary of each of these chapters.



Fast-growing cities:

Sydney, Melbourne, Brisbane and Perth.



Smaller cities and regional centres:

Smaller capital cities, satellite cities and regional centres home to more than 10,000 people.



Small towns, rural communities and remote areas:

Small towns with populations of fewer than 10,000 people and more than 200 people, regional communities with fewer than 200 people, and all remote areas outside of recognised settlements, including connecting infrastructure.



Developing regions and northern Australia:

Developing regions with strong growth prospects and where industry composition is changing, and northern Australia, including a mix of regions across the Northern Territory, and the northern parts of Queensland and Western Australia.



2. Future trends

The everyday lives of Australians are shaped by a range of interdependent global and local trends. These trends impact the way we live – how much we earn and our economic opportunities, our work-life balance, our health, and social connections – and influence how infrastructure is planned, built, used and managed.

In this chapter, we identify the seven future trends that we believe will play a decisive role in how Australia grows and changes over the next 15 years and beyond. These trends have formed a critical input for Infrastructure Australia in identifying the challenges and opportunities our economic and social infrastructure is set to face.

Quality of life and equity

In 2018

Australia ranked 3rd

in the world on the UN's Human Development Index ²²



Cost of living and incomes

Borrowing for housing makes up around

90% of total household debt

of Australians ²³

Technology and data

Just over 90%



of Australians own a smartphone (world average should reach 90% by 2036) ²⁵

Number of **single person** households will **increase** by over 60% to 2036 ²⁴



Population and participation

Community preferences and expectations

By 2028 women will control close to 75% of discretionary spending worldwide ²⁶

Environment and resilience



Australia's average annual equivalent CO₂ emissions per capita, nearly double the OECD average ²⁷



Economy and productivity

Emerging industries for Australia include: higher education, food exports, tourism, rare earths and new minerals ²⁸



Quality of life and equity

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

However, it can be challenging to access a high quality of life in particular parts of Australia, such as rural and remote areas, and for particular groups, including children and older people, those with disability, culturally and linguistically diverse communities, and Aboriginal and Torres Strait Islander peoples.

Cost of living and incomes

Our high quality of life translates into a high cost of living for many Australians. While average incomes have risen modestly over the past decade, the earning capacity of some Australians is declining, particularly in regions outside fast-growing cities.

Household budgets are increasingly under pressure from the cost of services and housing, despite many consumer goods becoming cheaper. Job security is becoming a key issue, particularly as new sharing and 'gig' economies create more transient and casualised workforces.

Community preferences and expectations

The expectations Australian communities place on governments, institutions, services and products are changing. Communities want greater choice and flexibility in their lives, in response to both social and technological advancements. We are living increasingly connected, digital lives.

Citizens, employees, customers and shareholders are expecting, and demanding, more. Our awareness of the world around us, and the impacts of our decisions and behaviours, is increasing. These preferences and expectations are often evolving ahead of government policy and regulation, and even political sentiment, creating challenges in ensuring changes bring benefits to all communities.

Economy and productivity

Australia has experienced a record-breaking 28 years of uninterrupted economic growth, with the size of the economy increasing by 130% in real terms since 1991, largely driven by our growing population and a significant export market for our natural resources.²⁹

Over this period, Australia has increased its global economic engagement, while avoiding the depth of economic crises that have affected other global economies, by building on our industry strengths and capitalising on our proximity to emerging Asian markets. However, our economy is experiencing

structural shifts, as service and knowledge industries drive employment and economic output, and economic activity is increasingly urbanised.

Population and participation

Australia has a small but rapidly-growing population by international comparison. At 25 million people, equivalent to the city of Shanghai, we are the 55th largest country in the world,³⁰ but growing at a faster rate than other developed nations (1.8% per annum compared to the global average of just over 1.5%).³¹ Net overseas migration is a large driver of this growth.

Within Australia, our population is densifying and urbanising, particularly in fast-growing cities. Some rural and remote areas are facing population decline. We are also more diverse, and ageing – which brings both challenges and opportunities. Participation in the workforce remains steady overall, but is increasing for women.

Technology and data

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

The pace and scale of technological change today provides profound opportunities for Australia – to improve lifestyles, provide better access to services, enhance efficiency and create new industries. However, technological advancements and data generation are increasingly also creating new challenges around control and privacy, and raising questions about how to ensure the benefits are available to all.

Environment and resilience

Australia's environment is one of extremes – a land of flood, drought, fire and cyclone. It is the driest inhabited continent on earth, with much of it unable to support intensive settlement.

Despite this, Australia's environment is the foundation of our social and economic wellbeing – we produce, consume and export high quality fresh food from the ground, we extract, consume and export valuable minerals from underneath it, we enjoy clean air, water and diverse landscapes, and people travel across the world to experience our unique flora, fauna and landscapes.

Today, our environment faces increasing pressure from human activity and the effects of climate change, affecting not only liveability and quality of life, but also our economic opportunities.



3. Infrastructure for users

This chapter examines the performance of infrastructure services through the eyes of users and identifies challenges and opportunities that require a national response:

- It explores the role of new technology and models of service delivery in improving user outcomes but identifies that these benefits may not be evenly shared across Australia.
- It examines issues of cost and affordability for households and businesses and finds that the average annual infrastructure bill for households is rising, with these costs hitting our most vulnerable hardest.
- It highlights the infrastructure challenges faced by fast-growing cities and finds that infrastructure services in these locations are struggling to keep pace with users' growing and changing needs.
- It explores the performance of infrastructure in Australia's smaller cities and regional centres, and finds that many of these areas have the capacity to serve as service hubs and satellite cities, taking some pressure off fast-growing cities.
- It finds that infrastructure service quality in many rural and remote communities often does not meet an adequate standard.



Access

Australians are most optimistic about **access to mobile and broadband services**, with

35% of people

expecting improvements ³²

Customer



Better functioning cities and towns could deliver a

\$29 billion increase

in GDP in the long term ³³

Quality

Without action, road and public transport congestion could double to nearly

\$40 billion by 2031 ³⁴

Asset

In 2018

877,651

kilometres of roads in Australia ³⁵



Cost



Australian households spent on average

\$314.39

on infrastructure per week ³⁶

Industry



Community opposition has contributed to the delay, cancellation or mothballing of more than

\$20 billion

of infrastructure projects in the last decade ³⁷

State of play: Infrastructure for users

In most parts of the country, users' needs are being met relatively well. Almost all Australians have safe, reliable running water and wastewater services in their homes.³⁸ They are connected to electricity grids that meet 99.998% of forecast customer demand.³⁹ There is near-nationwide access to broadband internet and one of the most extensive transport networks of any country. Most Australians have access to education,⁴⁰ health,⁴¹ and other social services that compare favourably with most other countries.

However, the scale of our country and the diversity of our needs present challenges for ensuring all users receive infrastructure services that are accessible, affordable and good quality.

Progress since the 2015 Audit

In the four years since the first *Australian Infrastructure Audit*, some infrastructure services have evolved considerably, driven by the availability of new technologies. For example:

- Ride and carsharing have provided new travel options for our cities.
- Household solar and storage technologies have enabled millions of Australian households to produce their own energy, export it to the grid and reduce their bills.
- Increasingly rich information is now at users' fingertips. Real-time data on congestion, transport timetables and public transport vehicle capacity, as well as energy usage, and a range of health and education services are being delivered via smartphones or online.

At the same time, a range of new challenges have emerged for infrastructure users:

- Across all parts of Australia, users feel infrastructure is adding to cost of living pressures. Energy affordability is a particular concern. Energy prices have risen by over 50% in the past decade – and by much more for some users.⁴²
- Congestion on our roads and crowding on public transport has worsened in many of our fast-growing cities.
- Some Australians still do not have access to high-speed internet, reliable mobile coverage or clean drinking water and sanitation.

Key messages

Infrastructure is only as good as the user outcomes it delivers. But across many parts of the country, and most sectors, there is a lack of reliable and user-focused information. This makes tracking progress against these user-focused outcomes difficult and increases the risk that infrastructure decisions may fail to focus on the long-term interests of users. Helpfully, increasing access to user data and use of behavioural insight tools can help regulators and service providers to better understand users' evolving needs and drive improved service quality.

Access to infrastructure services can vary greatly for users based on their location. Users in our cities have typically had access to high-quality infrastructure at affordable costs. However, the pace of growth and change in our fast-growing cities has put many legacy networks under strain. At the same time, relatively poorer access to services in many outer urban, regional and remote communities is reinforcing disadvantage. Technologies can help to overcome these barriers to access.

The cost of infrastructure across all sectors is a concern for every Australian. However, community perceptions on the scale of infrastructure cost rises do not always align with what they are actually paying.

Average household infrastructure costs have risen in real terms, but on average, they have decreased as a proportion of household incomes. However, infrastructure costs are regressive and hit lowest-income households hardest.

4. Industry efficiency, capacity and capability

This chapter examines infrastructure issues from the perspective of the infrastructure sector and discusses how the sector is responding to changing demands and how it can meet best practice:

- It identifies infrastructure planning and decision making that falls short of consistent best practice.
- It examines costs from the perspective of governments, service providers and investors, and identifies that there are challenges resulting from Australia's scale and diversity.
- It identifies that while there is improved visibility of the near-term pipeline, this does not appear to have resulted in better coordination of projects entering the market, limiting the capacity for industry to deliver.
- It explores national trends in procurement and contracting, and finds that high volumes of infrastructure activity are driving competition and capacity challenges, risking higher costs in the next 5 years.
- It identifies the mounting risks for Australian infrastructure from changes in technology, the economy, user preferences and the environment, and calls out that many resilience strategies do not provide adequate guidance.

Access

NSW and Victoria account for around

33%

of planned project activity ⁴³



\$39 billion

(2.1%) of GDP spent by governments **on infrastructure** in 12 months to December 2018 ⁴⁴

Quality



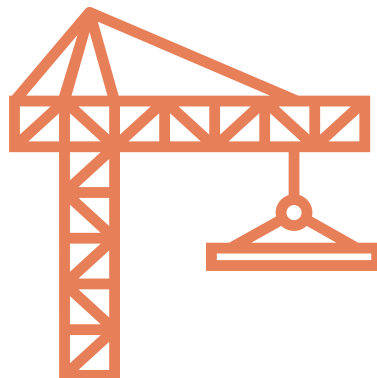
In 2018

90%

of potential investors are 'highly likely' to invest in Australia, up from 70% in 2017 ⁴⁵



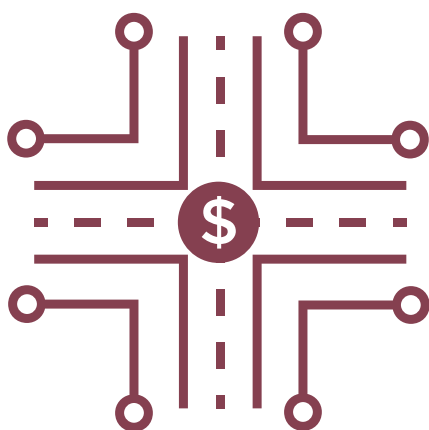
Asset



\$130 billion

of transport infrastructure projects under construction (2018) ⁴⁶

Cost



Since the last Audit, transport infrastructure investment has totalled

\$100.9 billion

(\$73.2b private, \$27.7b public) ⁴⁷

Over

20%

of GDP attributed to infrastructure sectors ⁴⁸

Industry



State of play: Industry efficiency, capacity and capability

Infrastructure is more than steel and concrete. It is also about the workers, engineers and project teams who design and build it, and users who rely on it for their daily needs. Infrastructure planners, financiers, operators and community engagement teams are all part of the tens of thousands of people that make up the sector. In total, the sector accounts for around 21% of national GDP,⁴⁹ and every dollar of value the Australian economy creates is reliant on infrastructure in some way.

Progress since the 2015 Audit

The 2015 Audit did not specifically examine the capacity of our industry. However, in light of the scale of investment and construction underway in the sector it has become clear that it requires close examination.

Since 2015, the infrastructure sector has changed. We have witnessed an increasing number of mega-projects being funded by state and territory governments in response to our rapidly growing population. Industry's role in delivering and planning these projects, and providing experienced and skilled labour will be tested over the course of the next 15 years.

Since the last Audit, Infrastructure Australia's Reform Series papers have focused heavily on the changing capability needs of the sector. Our analysis and the work of others has resulted in industry reform. In particular, the increased focus on population policy, improved data collection and reporting, and the emergence of new governance models for major urban infrastructure have contributed to an improved capability within the sector. Despite progress, and the considerable work from the people that make the industry, there remains room for improvement.

Key messages

How we plan, fund and deliver infrastructure has improved but Australia is not achieving best practice. Each decision to build or upgrade infrastructure can impact taxpayer and user bills for generations. Every dollar of public infrastructure investment can generate GDP increases that add up to \$4 of value over the life of the asset.⁵⁰ It's essential we get these decisions right to improve the quality, affordability and access to our infrastructure.

Funding options are often underdeveloped and projects face procurement issues. We face challenges in addressing funding shortfalls that impact our ability to fund the right projects, at the right time. The challenges and opportunities associated with where we source our funding, how we use grants and subsidies and funding our maintenance backlog, will impact the quality and access to our infrastructure and our economic strength.

Projects are getting larger and increasingly complex, and will require new approaches. How the public sector make decisions, handles procurement, selects contract models and handles risk will have significant bearing on the functionality and efficiency of our infrastructure. Alongside these changes new demands for sustainability, resilience and security will provide opportunities to achieve better outcomes. However, this makes the planning and management of industry capacity more complex.



5. Transport

Passenger transport

This section focuses on a broad range of modes, from active transport, such as walking and cycling, to private cars, public transport, aviation, cruise ships, ferries and emerging modes like rideshare. The chapter identifies a range of challenges and opportunities the sector faces in connecting people to places:

- It examines the impact of economic and social developments on urban transport demand and highlights the changing role of government from delivering to facilitating transport services.
- It explores how the private vehicle market is changing at a rapid pace, with sharing and connectivity already a common feature, the mass rollout of electrification likely to occur in five to ten years, and autonomous vehicles growing in sophistication over the next 15 years.
- It highlights the important economic contribution of our international, regional and remote airports and identifies the unique challenges they face.
- It discusses the lack of consistency and transparency across Australia for funding and maintaining our transport assets.
- It identifies the large and growing emissions footprint of passenger transport and discusses the role of transport network resilience in safeguarding the liveability and economic strength of our communities.
- It looks at the recent trends in road safety and notes that Australia is unlikely to meet targeted reductions in fatalities.
- It explores inequity of access to transport, with a specific focus on the financially disadvantaged, people with disability, older Australians and people who live in rural and remote Australia and the outer suburbs of our fast-growing cities.

Access

4 in 5 tram stops

in Melbourne are not accessible to customers with disability⁵¹



Quality



Australians drive the equivalent of

1,000 times from Earth to the Sun

every year⁵²



Customer

In 2031, public transport crowding will grow five times to cost Australia

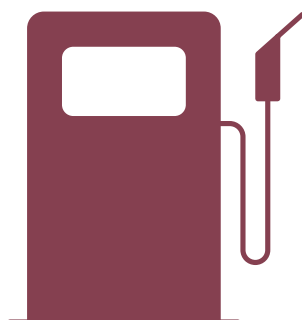
\$837 million per year⁵³

Asset

Australia's rail network is the length of a return trip to London from Sydney⁵⁴



Cost



An average household

spends around \$200 per week

owning and operating vehicles⁵⁵

Industry

8 Sydney Opera Houses could be built with the annual subsidy to public transport⁵⁶



State of play: Passenger transport

Australia-wide, there were 433 billion passenger kilometres travelled in 2015-16.⁵⁷ Cars are overwhelmingly the dominant passenger transport mode, accounting for 64% of the total, and 85% of all land-based passenger kilometres.⁵⁸

However, aggregated statistics only tell part of the story. People's travel habits are complicated and patterns of demand vary depending on context. Public transport is most competitive in our four fast-growing cities, accounting for about 20% of journeys to work in the cities combined.⁵⁹

Walking and cycling are also critical to the passenger transport network. Whether people drive or catch public transport, most trips have a walking component. While cycling is less popular, it comes with significant health and environmental benefits.

For long distance inter-city and regional trips, catching a flight is often the most practical solution. Australia has some of the busiest air routes in the world, with Sydney-Melbourne being the second busiest and Brisbane-Sydney the eighth.⁶⁰ Air travel is also critical for rural and remote communities, ensuring they have access to major centres and key services.

Finally, cruise ships are an important emerging industry in the transport and tourism sectors. There were 1.34 million cruise passengers in 2017, having quadrupled since 2010.⁶¹

Progress since the 2015 Audit

Most of the performance challenges regarding access, quality and cost identified in this chapter are consistent with the findings of Infrastructure Australia's 2015 Audit. Access remains inequitable, regional infrastructure is poorly maintained and costs have remained stable but impact some groups more than others.

However, looking forward, the location of future congestion has changed. This Audit has modelled the projected cost of congestion in 2031 using the same methodology as the 2015 Audit. The costs of public transport crowding will grow from \$175 million in 2016 to \$837 million in 2031. Similarly, the costs of road congestion will grow from \$18.9 billion in 2016 to \$38.8 billion in 2031. The overall cost of road congestion for 2031 in this Audit is about \$14.5 billion less than projected in 2015.⁶²

The reduction is the result of a combination of changes to inputs, particularly lower population projections by the Australian Bureau of Statistics, some changes to assumptions regarding travel behaviour, improvements to the model, as well as capacity increases to transport infrastructure networks since 2015.

Of the six modelled conurbations, the cost of congestion in the four less populated regions has reduced, reflecting a range of issues such as lower population forecasts and increased transport infrastructure investment. However, our two largest cities, Sydney and Melbourne, have higher congestion costs. This reflects substantial population growth in these two cities since the last Audit.

Key messages

Access to and the quality of our passenger transport networks is unequal. Transport can be particularly difficult to access for the financially stressed, people with disability, older Australians, people in regional and remote communities and in the outer suburbs of our major cities.

The quality of service also varies depending on where people live. Our large and fast-growing cities suffer from congestion while our remote communities often have poorly utilised and maintained assets.

Our passenger transport networks are at risk of becoming financially and environmentally unsustainable. There is a lack of transparency about why and how money is spent, particularly for maintaining our existing networks. Additionally, the transport sector is the second largest emitter of CO₂ in Australia (behind electricity), and emissions are growing.

However, there are also positive developments. The transport sector is in a state of rapid transition, with advances in communications technology, electric vehicles and eventually driverless cars offering customers unprecedented mobility and access to information, as well as potentially improving the environmental and safety performance of the sector.



Freight transport

This section focuses on the complex array of supply chains that transport imported and locally produced goods for domestic consumption, as well as our export supply chains:

- It explores the ability of our domestic and international freight networks to capitalise on world growth, especially in Asia, with a focus on the challenges faced by our main container ports and international airports.
- It analyses the challenges freight faces in our major cities, including poorly coordinated land-use and transport planning, the impact of congestion and the growth of micro freight.
- It investigates the efficiency of the domestic freight network, including the impact of inefficient regulatory structures, the potential benefits of technology for the freight sector and the importance of safety for road freight.
- It explores the diversity of regional supply chains and identifies the challenges of providing sufficient infrastructure for seasonal agricultural flows and the potential for freight investments to act as catalysts for regional development.
- It examines the challenges faced by Australia's waste sector, including growing pressure due to population growth, export bans and heightened environmental awareness.

Access

Customer



Australian exporters
**spend five
times more**
than Canadian exporters on
border compliance costs ⁶³



=



Every year
**three
truckloads
of freight**
is moved per person ⁶⁴

Quality

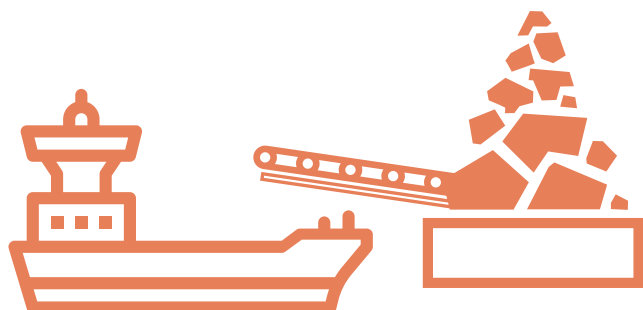


Delivery times could

**reduce
by 40%**

with autonomous vehicles ⁶⁵

Asset



Port Hedland is the worlds largest
bulk export port. It handled

**519,000,000
tonnes in 2017–18** ⁶⁶

Industry

Cost



Freight tonne kilometres
that are carried on rail ⁶⁷



Freight is **5%**
of the retail cost of doing business ⁶⁸

State of play: Freight transport

Australia's freight task is growing rapidly. In the ten years to 2016, the domestic freight task grew by 50%.⁶⁹ This task is expected to continue to grow, by another 26% between 2016 and 2026.⁷⁰

The freight task in Australia is diverse and the needs of individual supply chains can vary substantially. Our freight flows broadly encompass the following:

- The movement of bulk commodities, largely for export, such as iron ore, coal and liquefied natural gas (LNG)
- The transport of agricultural produce including grains, cotton, rice, sugar and livestock
- The import and transportation of manufactured goods, machinery and motor vehicles
- The transport of largely imported consumer items to retail outlets and, increasingly, direct to people's homes and offices
- Waste transport, disposal and recycling.

Progress since the 2015 Audit

Many of the challenges identified in Infrastructure Australia's 2015 Audit remain today. Freight continues to grow quickly, congestion on key urban freight routes remains, inconsistent regulation hinders efficiency and key regional bottlenecks still exist for agricultural supply chains. Australia's waste transport and management sector has also come under pressure as a result of new restrictions on the import of lower-quality recyclable materials to key export destinations.

There has been some progress on key reforms, but they remain incomplete. In 2011 Australian governments agreed to establish a national system of freight regulation, with the establishment of national regulators and progressive transition away from state laws. Since the 2015 Audit the transition to national rail safety regulation has been completed.

Progress has also been made with heavy vehicle regulation, with jurisdictions progressively transitioning to the National Heavy Vehicle Regulator. However progress is slow, and heavy vehicle regulations remain inconsistent and difficult for industry to understand.

Technology has progressed and begun to improve the efficiency of key freight facilities since 2015. For example, the introduction of automatic straddles at numerous ports means the transfer of containers from ships to trucks and trains is now automated. The impact of technology is likely to grow in the freight sector, with automation potentially reducing freight costs into the future. Finally, safety has improved since the last Audit, with a decline in the number of fatal crashes and number of deaths involving heavy vehicles. However, progress remains slow and road freight still has the highest fatality rate of any industry in Australia.⁷¹

Key messages

The performance of our freight networks varies. Australia is home to some world leading mineral supply chains, particularly in the Pilbara, Central Queensland and Hunter Valley. However, our urban and agricultural supply chains in particular are experiencing challenges.

Our cities are key centres of demand, supply and the processing of high value and containerised freight. However, too often they act as bottlenecks in our national supply chains, limiting access to key markets for exporters and increasing costs for consumers. Congestion on key routes, land-use planning that doesn't consider freight and regulatory constraints on our gateways are common.

Agricultural supply chains also suffer from constraints. Local infrastructure is often poorly maintained and lacks capacity. Infrastructure constraints are coupled with inefficient regulation in our regions, where freight operators often cross-jurisdictional boundaries and have to deal with a myriad of access permits.

Australia is one of the world's largest waste producers per capita, but our waste management is often poorly planned, and the sector is under increased pressure as waste generation increases and the capacity of infrastructure declines.

Australia is well positioned to take advantage of Asia's economic development. But to do so, we need to ensure our freight and supply chains operate efficiently and minimise costs for business and consumers.



6. Social infrastructure

This chapter examines the challenges and opportunities Australians face in accessing affordable, high quality social infrastructure across six sectors:

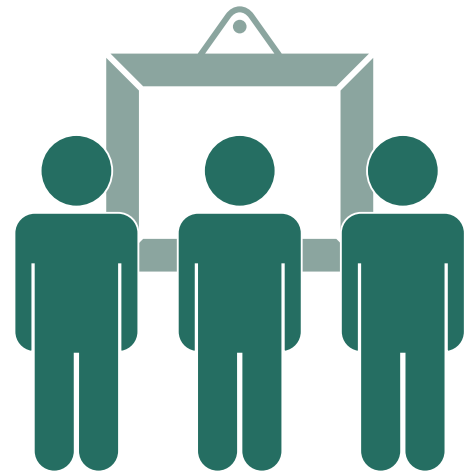
- It considers the infrastructure needs of hospitals, aged care facilities and digital health systems in the context of substantial increases in demand for services and facilities as our population grows and ages.
- It highlights the changing population and technological demands being placed on education infrastructure, from childcare and preschool through to tertiary and vocational levels.
- It explores the role of green spaces, waterways and community facilities play in providing social, economic and environmental benefits to communities. It also identifies fragmented governance as a key driver for unequal access, quality and cost of these spaces and facilities.
- It identifies the crucial role that arts and culture play in strengthening social inclusion and identity for Australian communities and it describes challenges for the sector in providing fit-for-purpose spaces.
- It analyses the challenges some Australians face in accessing adequate and affordable housing, in particular those who require social housing, and housing in remote areas.
- It examines how advances in technology in the justice system, and the changing nature of emergencies and disasters are placing pressure on ageing, often not fit-for-purpose infrastructure assets.

Health and aged care



Health services are rated as poor by
one in five people⁷²

Arts and culture



3 in every 10

international visitors to Australia in 2017
visited a museum or gallery⁷³

Social housing

4.4%

of **Australia's housing stock** is
social housing, compared to
around **17% in the UK** and less
than **1% in the US**⁷⁴

Justice and emergency services



Prisoners awaiting sentence represent

32%

of prison population⁷⁵

Green, blue and recreation

The quality of **green, blue and recreational infrastructure** is considered better than all other social infrastructure⁷⁶



Education

85%
of students

rated university learning and student
spaces as good or excellent in 2017⁷⁷

State of play: Social infrastructure

Compared to economic infrastructure, individual social infrastructure assets may be smaller in scale – a local public swimming pool, park or single social housing dwelling – however, together these assets form networks that deliver nationally significant benefits to the community, the economy and our environment.

On a national scale, social infrastructure sectors contributed 12.5% of Australia's GDP in 2018.⁷⁸ These sectors employ just over 3 million people (or around a quarter of Australia's workforce).⁷⁹ Australia has over 1,300 public and private hospitals,⁸⁰ and over 9,400 schools.⁸¹ We make just over 100 million visits to public pools every year,⁸² and over 80% of us attended an art and cultural venue or event in 2018.⁸³ There are close to 400,000 social housing dwellings across the country,⁸⁴ and over 40,000 prisoners in over 100 prisons.⁸⁵

Progress since the 2015 Audit

In a shift in approach from the 2015 Audit, Infrastructure Australia has considered both social and economic infrastructure in this Audit. In the four years since the last Audit was produced, population growth, coupled with technological advancements and an increasing expectation for personalised and transparent services has changed the way social infrastructure is being delivered in Australia.

Community perceptions of social infrastructure have also shifted:

- Australians feel that the quality of health and aged care has improved over the past four years, but affordability has decreased, particularly for older people.⁸⁶
- In the education sector, almost a quarter of Australians believe that quality has improved, while over a third have seen costs increase to participate in learning, particularly for those with or caring for someone with disability.⁸⁷

- Over a quarter of surveyed Australians say the quality, cost and accessibility of our social housing infrastructure has declined over the past five years.⁸⁸
- Perceptions of the quality of justice and corrections facilities have largely remained the same, while over a quarter of people feel the quality of parks and open spaces has increased.⁸⁹
- More than a quarter of surveyed Australians see the quality of arts and cultural facilities as having risen over the past five years.⁹⁰

Over this period, social infrastructure has also become increasingly digital, helping to provide services to more people and in a more personalised and up-to-date way. This is particularly evident in rural and remote areas, driven by the delivery of the nbn.

Key messages

Australia has high-performing social infrastructure sectors by international standards, as reflected in our ranking as the country with the third highest quality of life and standard of living in 2018.⁹¹ However, ease of access to and quality of social infrastructure varies for different types of infrastructure, across different places and groups of people.

For example, accessing a major art gallery may be difficult for someone living in a rural town, whereas they have access to large amounts of green space. Conversely, someone living in a city may experience delays at an overcrowded hospital, but may live close to a world-class university.

Different social infrastructure sectors are also closely tied, and many people need multiple and overlapping services and facilities. This provides opportunities to align sectors to achieve better outcomes, but also makes the planning and management of social infrastructure more complex for service providers.



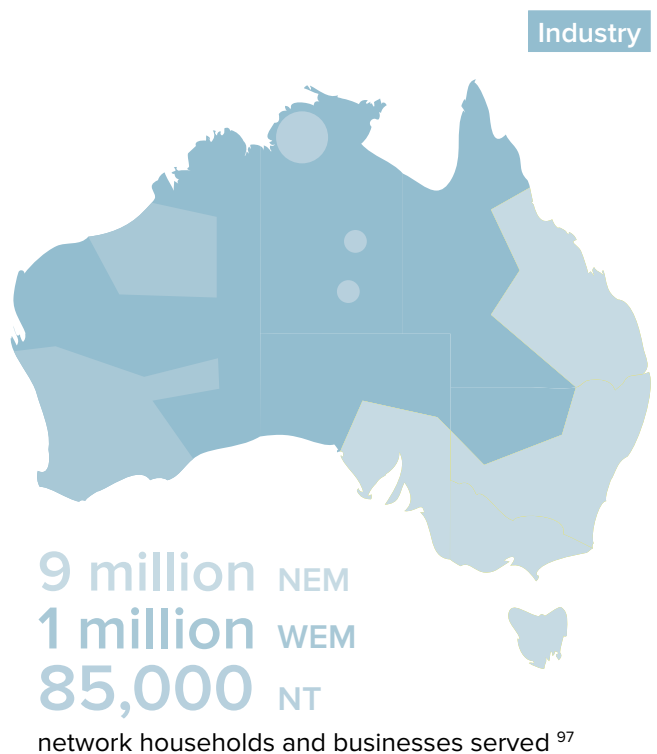
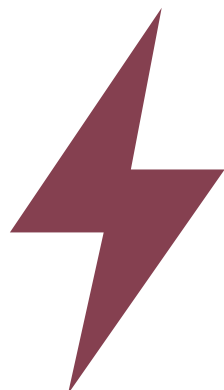
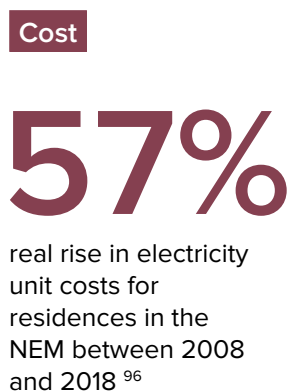
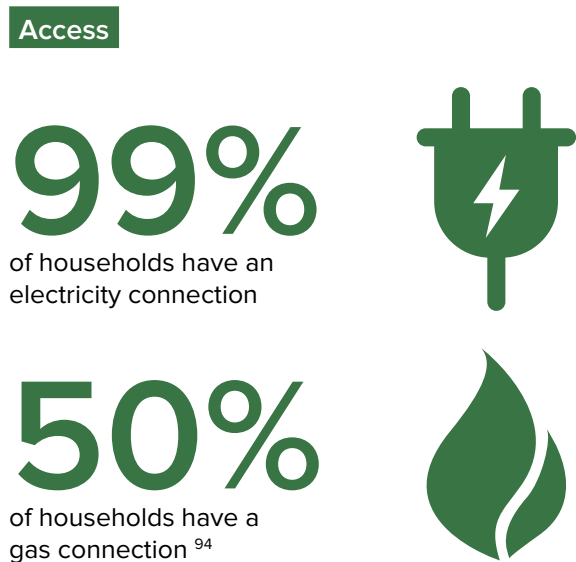
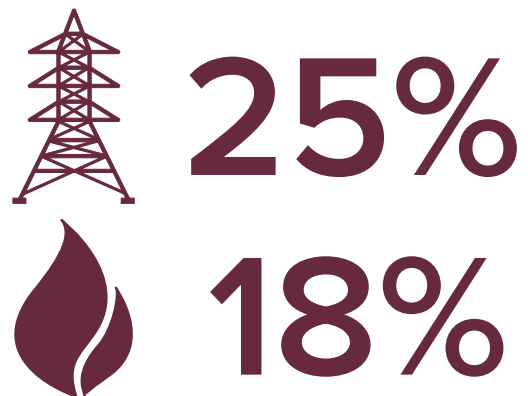
7. Energy

This chapter focuses on the factors affecting infrastructure in the stationary energy sector, including electricity generation, transmission and distribution networks, large and small storage infrastructure, and retail issues that affect infrastructure provision:

- It looks at how different groups of consumers and businesses are impacted by electricity and gas price rises, identifies the infrastructure-related components of affordability, and discusses how better information can help consumers manage their grid energy costs.
- It looks at key issues raised by the 2017 Finkel Review, including electricity reliability, different customers' willingness to pay, meeting climate policy commitments, and improving system resilience and security.
- It discusses Australia's short and longer term fuel market transition and identifies the challenges faced by each fuel, and the effect of new forms of generation.
- It considers the ability of current governance structures to manage, and lead, given the ambiguity regarding the withdrawal of existing large generators and their replacement with new forms of generation.
- It discusses the role of cheaper solar PV in providing choice for consumers and identifies the costs to the community of increased adoption and the challenges of integrating this technology with existing infrastructure.
- It highlights the costs and reliability of electricity provision in rural and remote areas and identifies opportunities to better meet these communities' needs.
- It considers opportunities that have the potential to enable Australia to become a new energy superpower.



Proportion of grid electricity and direct gas consumed by residential customers ⁹³



State of play: Energy

Australia's energy sector is undergoing a transformation, adapting to new generation sources and consumer preferences.

This change is most pronounced in the electricity market. Investment in energy networks grew rapidly over the past decade, with the value of assets in the National Electricity Market (NEM) growing by around 75%.⁹⁸ The generation mix is also rapidly changing. Older coal-fired generators are being retired or approaching end of life. In 2018, one in five households had rooftop solar, and 21% of electricity came from renewable sources. This figure will continue to climb off the back of \$20 billion in large-scale renewable energy projects in 2018 – twice that of the year before.⁹⁹

In gas, Australia has evolved from being a relatively stable, closed domestic market to the world's largest exporter of LNG in less than a decade.¹⁰⁰ Export terminals in Queensland have changed the dynamics of the East Coast gas market, exposing Australian users to higher global prices. The construction of a pipeline to link northern and eastern markets could bring further changes for domestic and global markets.

Progress since the 2015 Audit

The dominant issue in the energy sector since the last Audit has been the growth in energy prices. Over the past decade, the unit price of electricity has risen in real terms by 56%,¹⁰¹ while retail gas for households has risen by 45% over the same period.¹⁰² Many of the reasons for the spike in prices occurred prior to 2015 – including decisions to increase investments in electricity network assets, and to open the East Coast gas market to global forces through the construction of new export facilities in Queensland.

However, since 2015, wholesale electricity prices have risen steeply. This was caused by the closure of key coal-fired generation assets, issues with network reliability due to ageing assets, and rising costs for generation inputs such as coal and gas.¹⁰³

The impact of this steep climb in users' electricity bills has been a negative shift in user perceptions of affordability – with electricity seen as the least affordable form of infrastructure by Australian consumers,¹⁰⁴ and least likely to improve over the next five years.¹⁰⁵ This is despite energy costs not forming a large component of the average household's expenditure, ranking behind transport and telecommunications.¹⁰⁶

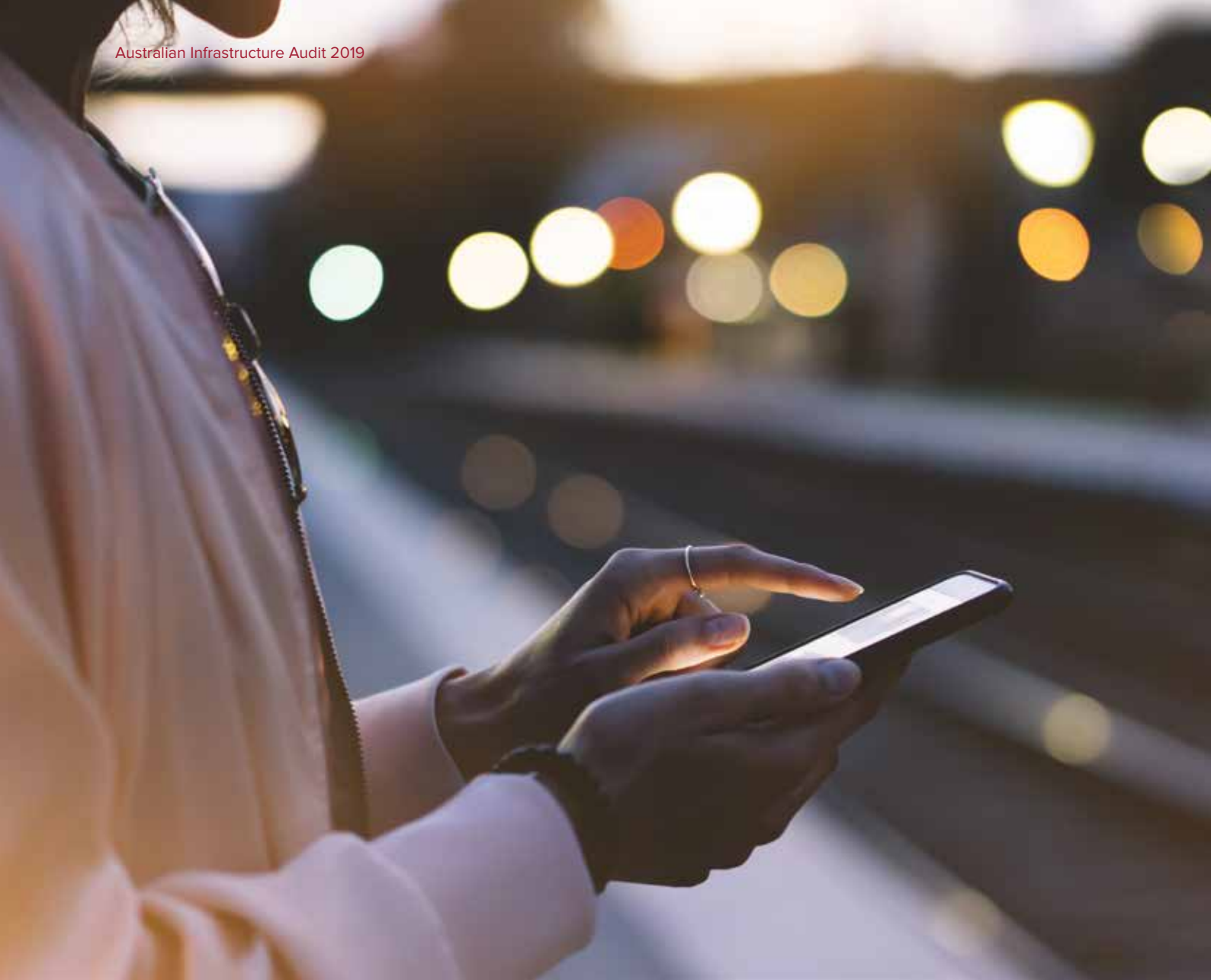
Concerns about lack of certainty expressed by Infrastructure Australia in the 2015 Audit persist in this Audit. The NEM, and the institutions which support its operation, have continued in the absence of decisive federal leadership, and a lack of certainty on energy or emissions policy. Retail reform has taken a back seat to settling future arrangements in the NEM as it transforms its input energy mix.

Key messages

For many years, Australia has held a comparative advantage in energy costs, as well as an abundance of natural energy assets. This has propelled our economy, supporting improvements in the productivity of our businesses and helping us to compete in global markets. There are indications that this advantage is slipping, but Australia can overcome current challenges and spur a new wave of growth off the back of our energy resources and industry capability.

Much of Australia's energy infrastructure is fixed, costly and long lived. Its markets are highly complex and sensitive to change. These characteristics are adding to the challenges of a sector that is undergoing a transformation, adapting to new generation sources and consumer preferences.

This energy transformation is occurring against a backdrop of climate change and ongoing policy uncertainty, with a lack of coordination across Australia's governments on how best to manage changes. The result has been a worse deal for many users, with bills rising rapidly over recent years and most users expressing dissatisfaction with the affordability of their energy services.¹⁰⁷



8. Telecommunications

This chapter focuses on four key issues impacting the telecommunications sector in the coming 15 years:

- It considers the increasing role telecommunications will play in supporting new services for people and businesses.
- It looks at our strengths in the provision of mobile services and identifies emerging challenges and opportunities created by the emergence of 5G.
- It considers how we can capitalise on the delivery of the nbn in order to maximise benefits for Australians.
- It identifies the challenges faced in ensuring no Australian is left behind in the digital world, in terms of digital literacy, access and affordability.

Quality

Customer

Australia ranks

57th

globally for fixed broadband speeds in June 2019 ¹⁰⁸26.9
millionmobile handset
subscribers in Australia ¹⁰⁹

Access

Asset



1 in 10

adults did not access the internet
at least once in the six months
leading to May 2018 ¹¹⁰

11.7 million

premises will be ready to
connect to nbn by mid-2020 ¹¹¹

Industry

Cost



2.5%

average annual decline in
revenue related to fixed
networks in Australia over
the last 4 years ¹¹²

44%

Proportion of consumers
that rate fixed broadband
as costly ¹¹³

State of play: Telecommunications

Telecommunications infrastructure covers the networks that carry voice and data between users across Australia, and our connections with the rest of the world. This includes wires, fibre, towers, sensors, satellites, radio spectrum and assets such as data centres and cable landing stations, which come together as networks to deliver communication to and from our devices.

Most of the telecommunications infrastructure in Australia is privately owned. The notable exception is the publicly-owned nbn, which is still in its initial rollout phase. nbn is solely a wholesale provider of broadband services, and sells access to its network to over 150 large and small retail service providers nationally,¹¹⁴ including major players such as Telstra and Optus, and smaller retailers such as Bendigo Telco, Central Coast Internet and Telecom West.

In the mobile service area, the three major mobile network operators are Telstra, Optus and Vodafone. These operators sell access to their networks to a range of over 50 other mobile service operators.¹¹⁵ These operators are often only active in specific, usually built-up areas.

Progress since the 2015 Audit

In the four years since the 2015 Audit, the role of telecommunications in the everyday lives of Australians has continued to increase. Australians' use of fixed broadband and mobile data has increased by 175% and almost 250% respectively, a growth rate that is many times faster than our economy overall.¹¹⁶

The 2015 Audit indicated the transformative role the nbn would play in Australia's future telecommunications landscape, and it remains so in this Audit. It noted that 818,000 premises were nbn ready (about 7% of all premises), and that 346,000 had connected to the service by February 2015 (3% of premises). Today, the nbn is over half way to its target of delivering peak wholesale download data rates of at least 25 megabits per second to all premises, and 50 megabits per second to 90% of fixed-line premises by 2020.¹¹⁷

In 2015 the Audit focused on 3G and 4G mobile services. In 2019, 2G and 3G mobile networks are largely obsolete, while there is significant ongoing private investment in 4G network upgrades. The arrival of 5G networks is imminent, and the likely step change is substantial.

Key messages

Telecommunications is increasingly central to our personal lives and to the way we work and do business. Business and government are rapidly moving services online. As almost all of us rely on these services, access to networks that keep us connected is increasingly essential to our day-to-day lives.

However, digital disadvantage remains a challenge for certain groups within the community. For those in areas with good access, the challenge is how to increase digital literacy and to make telecommunications access more affordable. In rural and remote settings, the cost of providing telecommunications infrastructure increases and the returns reduce as population densities decline. This limits the scope for universal coverage by commercially-focused private sector operators, without government intervention.

Consumers are generally positive about the quality of their telecommunications services, although rural and remote Australians are less positive about their experience. Consumers also view telecommunication services as costly and are concerned about paying more.

The continuing evolution of digital technologies, which rely on telecommunications networks, represent a significant opportunity to enhance Australia's economic productivity. Embracing these new technologies will be a source of competitive advantage for Australia and can improve outcomes for users.



9. Water

This chapter examines the key trends impacting the water sector across urban and productive markets, and in different parts of the country:

- It identifies the range of challenges facing urban water, including population growth in our cities, the impacts of climate change and increasing concerns over the health of our waterways.
- It explores options to enable the sustainable provision of water that supports the ongoing liveability of our cities.
- It examines the challenges facing water and wastewater services in regional and remote communities, and identifies the risk that Australia is not meeting acceptable standards in remote communities.
- It explores the governance of the water sector and finds that the value of water is not well understood, resulting in decision-making processes that do not meet best practice.
- It looks at the challenges we face in balancing the competing needs for water, and identifies that complexity and a lack of transparency in existing water markets is undermining the social licence and community confidence.

Access

NT 63% ACT 99% AUS 93%

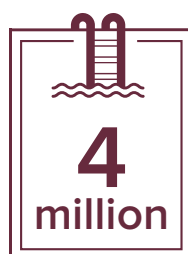
Residents with access to mains water from a utility with over 10,000 connections ¹¹⁸



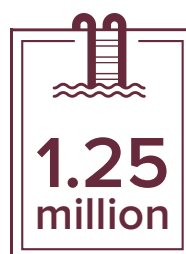
Quality

Customer

Annual water consumption in Olympic swimming pools ¹¹⁹



Agricultural



New Murray-Darling Basin environmental flows



Residential households

80 litres

of water lost by utilities per connection on average each day ¹²⁰



Asset

Unknown

The age and condition of urban water assets across the country

Industry



27,000

people employed in water supply, sewerage and drainage services, adding

\$18.9 billion

to the economy ¹²²

Cost



Cost of water per kilolitre for households and industry ¹²¹

\$3.28

\$0.28

State of play: Water

Water supports almost every part of our lives, from the functional – clean, reliable drinking water and safe wastewater services, to the social – providing green spaces and clean waterways, and the environmental – sustaining natural life, enhancing biodiversity, and supporting natural habitats of flora and fauna.

The Australian water sector provides essential services to almost all people and businesses. Across the Australian economy, users consumed around 16,500 gigalitres of water in 2016-17, which is enough to fill Sydney Harbour 33 times.¹²³ Water and wastewater services are delivered by around 196 businesses and local governments in Australia's cities and towns. There are also a range of smaller licensees that provide local and specialised services, including in remote communities.¹²⁴

Progress since the 2015 Audit

In the four years since the last Audit, a range of issues have emerged in the water sector that have come as a shock to many people. These include concerns about running out of drinking water in some regional towns, fish deaths in parts of the Murray-Darling Basin, and rising bills to pay for expensive infrastructure upgrades. For many, this may be the first time they have considered risks to Australia's water, or the potential impacts of failure to meet users' needs.

These events are no reason to lose faith in the capacity of the water sector to provide high quality services, reliably and efficiently in future. However, they do provide a reminder to governments and service providers. These events also provide impetus for renewed efforts to progress important reforms to ensure Australians can continue to receive reliable services in the future, and know that water is being managed in a way that balances competing needs and mitigates risks efficiently.

Key messages

Australia's water sector has typically performed well in meeting the needs of businesses and households over many years across most of the country. However, the sector faces unprecedented risks and challenges. Climate change, population growth, ageing assets, and competing interests will ramp up pressure for limited resources. Advances in technology, markets and planning can help to overcome these challenges, but many will require changes in laws and regulations to unlock benefits.

The true value of water is poorly understood by users and many in the sector. Unreliable and incomplete evidence undermines the effectiveness of decisions, and community confidence in water managers. Overcoming the challenges faced by the water sector and preparing for the future will require a shift in planning and decision making to ensure the long-term interests of a range of stakeholders are protected.

Water services in some parts of the country do not meet an acceptable standard. Advances in urban water in metropolitan areas risk leaving large parts of the country behind. There are significant barriers and costs for delivering safe and reliable water and wastewater to all Australians. Without action, these barriers could drive further inequality, and undermine progress towards national targets and commitments.

Next steps

Completing this Audit is the first step in a program of work by Infrastructure Australia to plan for Australia's future infrastructure.

The next *Australian Infrastructure Plan* will consider each challenge and opportunity identified in this Audit that requires action via policy reform. The *Infrastructure Priority List* will respond to challenges and opportunities that require action via infrastructure investment.

The process does not end there. Once the reform and investment priorities are set, Infrastructure Australia will track and publically report on progress. We will track Australia's progress against meeting the reform targets set by the Plan and progressing the potential investments highlighted in the *Infrastructure Priority List*.

We welcome your input

To help us shape the future, we want to know what you think about this Audit.

For the next three months we will work intensively to engage with governments, community and industry. There will likely be differing views, and there may also be gaps in our evidence. We don't have all the answers, so we need your help to get this right.

To give feedback on our Audit, you can:

- **Make a submission** to tell us what we got right, what we missed, and what responses may be needed – such as policy reform or project investment. When you give this feedback, please respond directly to a relevant challenge or opportunity.

- **Provide new evidence**, if it is available and not reflected in the Audit. Please do this in a submission, or over time as evidence becomes available. Your contribution will ensure our evidence base stays as up to date as possible.

Anyone can make a submission

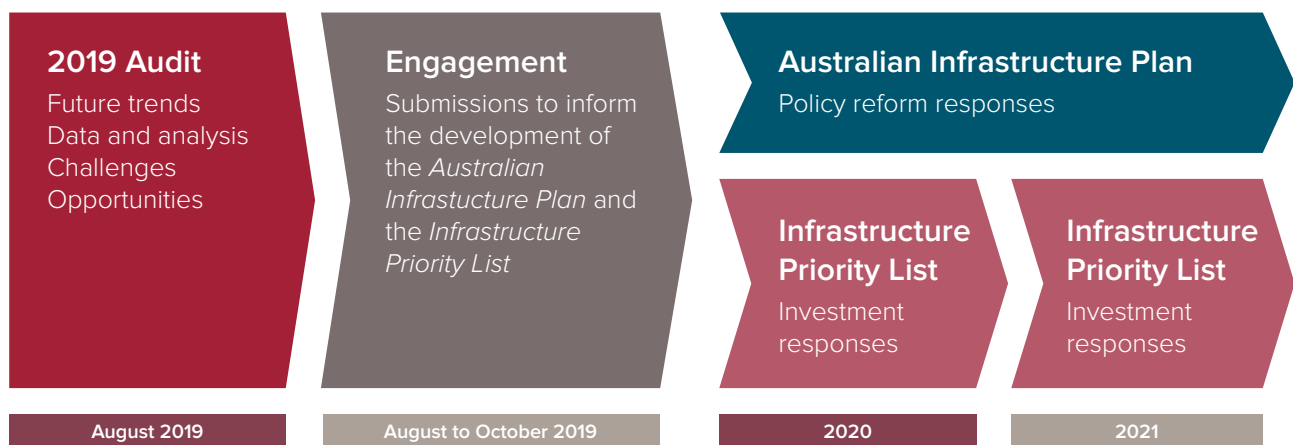
We encourage everyone to get involved from governments, industry experts and peak bodies, to academics, community groups and individual Australians. This is your chance to have a say on our infrastructure for the next 15 years and beyond.

To comment on individual challenges and opportunities, or download a longer template with room for more supporting evidence, visit the Infrastructure Australia website www.infrastructureaustralia.gov.au.

If your submission includes a specific investment proposal, you should provide supporting documents through the separate *Infrastructure Priority List* submissions process, which closes on **31 August 2019** for this round. If you submit after this date, we will consider your submission for the 2021 publication, along with the next *Australian Infrastructure Plan*. Figure 1 provides an overview of the submission process and indicative timings.

Your submission should identify which Audit challenges and opportunities each initiative or project responds to.

Figure 1: We invite submissions to help shape our future advice



iv. Challenges and opportunities

The Audit identifies 180 challenges and opportunities. These are not recommendations. Instead, they provide a clear assessment of the key issues likely to impact the access, quality, and cost of infrastructure,

and form the starting point for the investment priorities and reform recommendations to be identified in the *Australian Infrastructure Plan* and the *Infrastructure Priority List*.

Key: Challenges and Opportunities

0–5 Years	National
5–10 Years	Fast-growing cities
10–15 Years	Smaller cities and regional centres
15+ Years	Small towns, rural communities and remote areas
	Developing regions and northern Australia

Infrastructure services for users



Infrastructure that works for users

1. Challenge

Governments and service providers do not always adequately measure and report on access, quality and costs for users. Insufficient user-focused data makes it difficult for users and policy makers to make decisions that improve user outcomes.

When this will impact:



Where this will impact:



2. Opportunity

Technologies can help to overcome barriers to service access as a result of distance or location. Better access to services through improved technology can bring economic and social opportunities for users outside of fast-growing city centres.

When this will impact:



Where this will impact:



3. Opportunity

User data and customer insights can enable innovation to better meet users' needs. Better understanding users' needs can help operators to improve user experience, attract more users and provide services more efficiently.

When this will impact:



Where this will impact:



4. Challenge

Users that are disadvantaged, such as those with low digital literacy or with disability, may be unable to access infrastructure services provided through new technologies. Not extending the benefits of change to all Australians is likely to increase inequality and reduces quality of life by limiting access to services for some members of the community.

When this will impact:



Where this will impact:



Costs and affordability

5. Challenge

Limited reliable data exists to allow government, regulators and users to understand the total costs of infrastructure. Poor data limits the ability for government to understand the affordability of infrastructure services and cost of living pressures.

When this will impact:



Where this will impact:



6. Opportunity

Improved collection of data, including by third parties (such as financial institutions) could support improved decision making using big data. Partnering with data owners to support the collection of detailed, up-to-date data, will allow better decision making. However, data privacy will need to be managed.

When this will impact:



Where this will impact:



7. Challenge

User-pays funding for infrastructure has widespread support within the community. However, its regressive nature disproportionately affects low-income earners. Transport, energy, water and telecommunications infrastructure user costs are above affordability thresholds for our lowest income earners thereby reducing access to services and quality of life.

When this will impact:



Where this will impact:



8. Opportunity

Some users have limited information or understanding of the costs associated with their use of infrastructure, however new technologies will increase information and control for those that can afford them. New technology will increase transparency of infrastructure costs for users and provide the opportunity for consumers to invest in alternatives to substitute or replace traditional services.

When this will impact:



Where this will impact:



Infrastructure for fast-growing cities

9. Challenge

Rapid growth in Sydney, Melbourne, Brisbane and Perth has brought many benefits, but has also put legacy infrastructure under increasing strain. Without action, infrastructure constraints will add to economic, social and environmental costs, eroding the productivity of these cities and reducing quality of life for residents.

When this will impact:



Where this will impact:



10. Challenge

Unreliable and inconsistent population projections makes planning for future needs difficult. This uncertainty may undermine confidence in infrastructure investments, or delay vital network upgrades to meet future growth, reducing long-term productivity and liveability of our fast-growing cities.

When this will impact:



Where this will impact:



11. Challenge

In fast-growing cities, many of our most vulnerable or disadvantaged groups, including Aboriginal and Torres Strait Islander people, suffer from poor access to services. This can reinforce disadvantage and limit opportunities for improvements in quality of life through vital links to employment opportunities, education, health, recreational and cultural facilities, and other services.

When this will impact:



Where this will impact:



Infrastructure for smaller cities and regional centres

12. Opportunity

Smaller capitals and satellite cities have capacity to grow, and in turn take pressure off infrastructure in our fast-growing cities. Satellite cities can support growth by leveraging the infrastructure of their fast-growing neighbours and smaller capitals, through leveraging infrastructure designed to support their surrounding region.

When this will impact:



Where this will impact:



13. Challenge

Developments in the economy, regulation, technology and service delivery mean our infrastructure needs are changing, leaving some regional centres at risk of being left behind. Lags in infrastructure quality and access to services in smaller cities and regional centres could lead to a growing gap in productivity and liveability, relative to larger cities.

When this will impact:



Where this will impact:



Infrastructure for small towns, rural communities and remote areas

14. Challenge

Infrastructure is more expensive to provide per unit of consumption in low population density areas, but communities and businesses in these areas are also more reliant on available infrastructure for their productivity and wellbeing. Poorer infrastructure services in small towns, rural communities and remote areas could lead to limited opportunities for growth and may undermine the long-term viability of some communities.

When this will impact:



Where this will impact:



15. Challenge

Regional infrastructure faces a range of unique challenges and risks, which make it difficult to efficiently provide services that support growth in regional industries. Failure to overcome the challenges and risks facing regional infrastructure raise costs and barriers for investment in regional industries, limiting opportunities for employment and growth, and eroding confidence in the future viability of some areas.

When this will impact:



Where this will impact:



16. Challenge

Infrastructure can do more to support Aboriginal and Torres Strait Islander peoples in remote communities and rural areas, and to underpin progress towards local and national objectives for improving quality of life. Failing to improve services for First Australians in remote communities and rural areas undermines potential improvements in quality of life and reinforces gaps in inequality and disadvantage.

When this will impact:



Where this will impact:



Infrastructure to support regions and unlock growth in northern Australia

17. Challenge

Fluctuations in economic activity in regional industries make it difficult for infrastructure to efficiently and sustainably underpin long-term growth and development. Failure to keep pace with growth can reduce productivity and output during boom years, while underutilised assets raise costs in areas with declining populations, undermining the long-term social and economic viability of regional communities.

When this will impact:



Where this will impact:



18. Opportunity

Infrastructure can help to catalyse growth across northern Australia, and unlock development across a range of industries. Improving the resilience, reliability and efficiency of northern infrastructure could help to capitalise on the immense potential of northern regions, and improve the productivity, quality of life and competitiveness of its people and businesses.

When this will impact:



Where this will impact:



19. Opportunity

Development in northern regions could benefit from more detailed information and evidence-based studies of economic opportunities, as well as a better understanding of local needs and values, particularly of local Aboriginal and Torres Strait Islander peoples. Better information on opportunities and local needs can support more efficient investment and greater benefits for northern communities.

When this will impact:



Where this will impact:



Industry efficiency, capacity and capability



Planning and decision making

20. Challenge

Decision-making processes across many jurisdictions and sectors are not meeting best practice standards, including application of the *Infrastructure Decision-making Principles*. Failure to improve project decision making is likely to reduce the potential productivity and quality of life improvements of infrastructure investments.

When this will impact:



Where this will impact:



21. Challenge

Many decisions are being made without meaningful engagement, and without the means for comment and stakeholder feedback to inform project planning and delivery. By not adequately engaging, governments and proponents miss the opportunity to address stakeholders' concerns, ensure projects and reforms meet their needs, establish social licence and build trust in decisions.

When this will impact:



Where this will impact:



22. Challenge

Across many infrastructure markets, regulatory principles are complex, inconsistent, do not sufficiently protect the long-term interests of users, and reporting does not always align with user outcomes. A lack of clarity on user-focused objectives is likely to lead to worse outcomes for many users, and frustration with the perceived complexity of markets and decision making.

When this will impact:



Where this will impact:



23. Challenge

How infrastructure is provided and used will transform over coming decades, meaning laws and regulations will need to be reviewed, removed or updated. Failing to anticipate and adapt to change will undermine Australia's global competitiveness, stifle innovation and reduce the benefits of productivity-enhancing technologies.

When this will impact:



Where this will impact:



Funding and financing

24. Challenge

Funding for public infrastructure has risen above historic trends, but remains below that of many OECD nations and may need to rise further to maintain or improve user outcomes. Without sufficient funding for public infrastructure, outcomes for users will deteriorate over time, undermining productivity and quality of life.

When this will impact:



Where this will impact:



25. Challenge

Many community service obligations lack transparency, are not frequently reviewed, and may be inefficient. Opaque funding arrangements erode community support for CSOs and the benefits they deliver, while the lack of consistent review processes means taxpayers cannot be sure that this funding is efficient and delivers value for money.

When this will impact:



Where this will impact:



26. Challenge

A historical underspend on preventative maintenance, short budgetary and funding cycles, a lack of data and incentives, and inadequate reporting have contributed to a maintenance funding backlog across infrastructure sectors. An ongoing maintenance backlog will erode quality and reliability of many assets, and bring higher costs for future asset maintenance and renewal.

When this will impact:



Where this will impact:



27. Opportunity

Low or non-capital better-use solutions to infrastructure problems could help to avoid or delay investment in expensive new or upgraded assets. These solutions could stretch public funding for infrastructure further, bringing productivity benefits for more users sooner.

When this will impact:



Where this will impact:



Market depth and skills

28. Challenge

Increased transparency of the infrastructure pipeline has not improved coordination on the timing and release of projects into the market, leading to some stretching of resources. A lack of coordinated procurement and delivery activity is resulting in constraints in key resources and skills.

When this will impact:



Where this will impact:



29. Challenge

The overall volume and project scale of infrastructure construction has created a heated, stretched construction market and reduced competition for projects. High risk projects are not achieving a desired level of competition during procurement. This may result in delivery being delayed or delivered by a higher risk, lower skilled contractor.

When this will impact:



Where this will impact:



30. Challenge

Despite meaningful progress in key jurisdictions and large agencies, the public sector is inadequately skilled and resourced to undertake a high volume of sophisticated procurement activity, including the oversight of projects during the delivery phase. Inadequate public sector procurement expertise can result in the taxpayer being exposed to inappropriate risks or costs, and compromising the capability of projects to achieve user outcomes.

When this will impact:



Where this will impact:



31. Challenge

There are skill constraints for key roles within the sector. The entrenched construction sector culture is limiting the sector's attractiveness to potential future employees.

When this will impact:



Where this will impact:



Procurement and contracting

32. Challenge

Truncated bidding timelines, unnecessary documentation requirements and under-resourced government project teams are leading to poor procurement and delivery outcomes. This results in higher levels of risk and uncertainty being priced into tenders. These costs are ultimately carried by the users through poor quality services or additional costs, or met through government reimbursements.

When this will impact:



Where this will impact:



33. Challenge

Community pressure can encourage premature project commitments or the acceleration of project delivery. Decision makers are often poorly resourced to respond to this pressure to arrive at an informed decision. Poorly planned, budgeted or scoped projects can result in project cost blow-outs or delays, as well as a failure to meet project objectives, resulting in long-term costs to users.

When this will impact:



Where this will impact:



Security, resilience and sustainability

34. Challenge

Anticipating and mitigating against ever-changing risks to infrastructure is becoming more difficult as assets and networks become more interdependent and complex. Australia lacks comprehensive resilience strategies for its assets and networks. A failure to appreciate and plan for risks to infrastructure may impose substantial financial, social and personal costs.

When this will impact:



Where this will impact:



35. Challenge

Climate and cyber risks are likely to pose considerable and growing threats to Australia's infrastructure. Enhanced consideration of the risks to infrastructure can assist planning, design and operation of assets and networks, and can improve the resilience of services and reduce costs to future generations of users and taxpayers.

When this will impact:



Where this will impact:



36. Opportunity

Australia could lead the world in developing and applying sustainability-enhancing approaches to its infrastructure. Taking the lead on sustainable infrastructure practices can benefit current and future generations of Australians, while providing opportunities for our businesses to share their expertise and innovation through exports and international development programs.

When this will impact:



Where this will impact:



37. Challenge

Australia is at risk of not meeting its 2030 Paris Agreement commitment to reduce emissions by 26-28% below 2005 levels. Australia's future emission reductions are limited by increases in emissions from transport, direct combustion and fugitive emissions.

When this will impact:



Where this will impact:





Transport

Changing urban travel patterns

38. Challenge

Urban travel patterns are becoming increasingly complex, driven by economic, social, demographic and technological changes. There is a risk of growing divergence between the way our networks are planned and designed, and the needs of customers. Failure to cater for changing patterns of travel could contribute to growing congestion in our fast-growing cities.

When this will impact:



Where this will impact:



39. Challenge

Rapidly changing land use and development can place pressure on urban transport networks. Densification in our largest cities places pressure on legacy networks, while greenfield development requires new infrastructure and services. Failure to coordinate land use and transport planning can contribute to congestion and crowding in some areas, or a lack of adequate services in others.

When this will impact:



Where this will impact:



40. Challenge

Our radial public transport networks are inflexible and have varied levels of service and relatively low mode shares. Unless our public transport networks are designed to cater for a broader range of trips, they will not meet the changing needs of a growing number of customers.

When this will impact:



Where this will impact:



41. Opportunity

New technology and data sets are increasingly available in the transport sector, that can be used for planning and service delivery. Better information allows governments and operators to better understand and cater for customers' transport needs and expectations.

When this will impact:



Where this will impact:



42. Challenge

Australia has relatively low rates of active transport, driven by a range of issues including low densities and long distances, insufficient infrastructure and safety concerns. Without action, our transport networks and travel patterns will remain poorly integrated and sustainability improvements will be limited.

When this will impact:



Where this will impact:



Technology and the future of passenger cars

43. Challenge

The accessibility and affordability of ride and carsharing could decrease demand for public transport. In these circumstances, demand shifts from space efficient public transport back to cars, potentially increasing congestion.

When this will impact:



Where this will impact:



44. Opportunity

Connected vehicles can reduce accidents, improve traffic flow and reduce costs for drivers. Leveraging this new technology could improve access, quality and cost outcomes for users.

When this will impact:



Where this will impact:



45. Challenge

Many regional, remote and rural communities do not have the economies of scale to justify private investment in charging infrastructure. Without charging infrastructure, users in these areas will have fewer opportunities for electric vehicle uptake.

When this will impact:



Where this will impact:



46. Challenge

There is a lack of appropriate regulation, trials and physical infrastructure to enable the use of many cooperative and autonomous vehicle features. Without action, the benefits offered by cooperative and autonomous vehicles will be missed.

When this will impact:



Where this will impact:



International, inter-state and inter-regional connectivity

47. Challenge

There is congestion on roads around our major airports, particularly in Sydney and Melbourne. Unless addressed, travelling to airports will become increasingly unreliable, leading to longer travel times.

When this will impact:



Where this will impact:



48. Challenge

Some of our major airports are subject to operational restrictions reducing airport efficiency however adding to local amenity. Without regular reviews to ensure regulation is fit for purpose, the efficiency of our airports could be unnecessarily compromised.

When this will impact:



Where this will impact:



49. Challenge

Governance and funding of our regional road networks is inconsistent and lack transparency. This means funding and maintenance is subject to budget volatility of different levels of government. Without change to road network governance, our regional roads will continue to be poorly funded, maintained and safety may decline.

When this will impact:



Where this will impact:



50. Challenge

Regional aviation often struggles to be financially viable and customers view it as costly. Without action, regional and remote communities will lack access to air services and affordable airfares.

When this will impact:



Where this will impact:



51. Challenge

Our regional railways generally have uncompetitive travel times with cars and planes. This means they carry a relatively small share of passengers. Unless travel times are improved, regional rail will continue to play a small role, meaning regional customers have less choice when they choose to travel.

When this will impact:



Where this will impact:



52. Challenge

The popularity of cruise ships in Australia is growing, producing important tourism opportunities for fast-growing cities and regional centres. However, there are a lack of berths for international cruise ships, particularly in Sydney. Without additional berthing capacity, Australia will lose cruise ships and tourist visitation will decline.

When this will impact:



Where this will impact:



Funding and maintaining our transport assets

53. Challenge

Asset maintenance lacks transparency, consistency and accountability. This is particularly the case for sectors that rely on government funding rather than user charges, such as roads and public transport. Unless addressed, maintenance of our transport networks will become increasingly unsustainable.

When this will impact:



Where this will impact:



54. Challenge

There is no clear link between expenditure on roads and usage, which means road expenditure is inequitable, inefficient, unsustainable and lacks transparency. Without reform, revenue from fuel excise will decline, drivers will not be charged fairly and people will be incentivised to drive, contributing to congestion.

When this will impact:



Where this will impact:



55. Challenge

Public transport investments and operating subsidies are substantial, but decisions lack transparency. Unless addressed, public transport will continue to be subject to political cycles and budget conditions.

When this will impact:



Where this will impact:



56. Challenge

Regional and remote local governments struggle to fund and maintain roads and airports. Local governments often have relatively small revenue bases but are responsible for the maintenance of expensive transport networks. Without addressing funding shortfalls and maintenance practices, regional and remote infrastructure will become increasingly unsustainable.

When this will impact:



Where this will impact:



57. Opportunity

There are numerous emerging revenue sources for the transport sector, with many related to technological development and changing patterns of demand for transport. There is an opportunity for emerging revenue streams to improve the financial sustainability of our transport networks.

When this will impact:



Where this will impact:



Passenger transport sustainability and resilience

58. Challenge

Transport sector emissions are increasing. Passenger cars account for the vast majority of emissions, but heavy vehicles and aviation are projected to drive growth in emissions in the next ten years. Without action, the emissions intensity of passenger transport may cause negative environmental impacts and Australia will fail to meet its emissions reduction targets.

When this will impact:



Where this will impact:



59. Challenge

Australian governments often do not incorporate sustainability or resilience into their final infrastructure projects. Without regular action, active and public transport modes will be underutilised and our infrastructure will be less resilient and sustainable.

When this will impact:



Where this will impact:



60. Opportunity

If partnered with low carbon intensity fuels hybrid electric, plug-in electric, hydrogen fuel cell and automated vehicles are less emissions intensive than internal combustion engine vehicles. These technologies can be leveraged to transition to a low-carbon transport sector. Reducing transport sector emissions would help Australia meet its international obligations while also improving local air quality.

When this will impact:



Where this will impact:



61. Challenge

Climate change is likely to cause increasingly frequent and severe weather events that damage transport assets. Without resilient infrastructure, network functionality could be limited and the costs of upgrades could be more substantial.

When this will impact:



Where this will impact:



Safety in the transport sector

62. Challenge

Road safety performance is not on track to meet the objectives of the National Road Safety Strategy. Without action road users will continue to be vulnerable and at risk of serious injury or fatality.

When this will impact:



Where this will impact:



63. Challenge

Project selection and funding is based on incomplete safety data. Without action, this will inhibit effective cost allocation and understanding of trade-offs with other transport outcomes, such as productivity.

When this will impact:



Where this will impact:



64. Opportunity

Regional, rural and remote road networks are less safe. There is an opportunity to focus investments and policies on these areas. Identifying, assessing and prioritising sites for upgrades and road treatments on high risk corridors could optimise investment and reduce fatalities.

When this will impact:



Where this will impact:



65. Challenge

Australians are holding on to their vehicles for longer. Older vehicles often do not meet modern safety standards and are more likely to injure or kill if involved in a crash.

When this will impact:



Where this will impact:



66. Challenge

Pedestrian and cyclist fatalities are over represented in fatalities and injuries. Without action, active transport users will continue to be injured and killed, and the attractiveness of active transport will remain low.

When this will impact:



Where this will impact:



67. Challenge

Technological change is driving the collection of valuable data by transport operators and network owners. This information is valuable and can be vulnerable to cyberattacks.

When this will impact:



Where this will impact:



Transport accessibility and equity

68. Challenge

Public transport service levels and access is lower in the outer suburbs and regional centres. This results in lower public transport mode share, and a reliance on cars in these areas. Without action, people who live in these areas will continue to be reliant on their cars.

When this will impact:



Where this will impact:



69. Challenge

People on the outskirts of our cities and in regional and remote Australia pay proportionally more for transport. Unless addressed, our transport networks will continue to be inequitable, with people in the outer suburbs and regional and remote Australia paying proportionally more.

When this will impact:



Where this will impact:



70. Challenge

There is insufficient funding to make our public transport networks accessible to people with disability. Unless funding shortfalls are addressed, legislated accessibility targets for public transport will not be reached and our networks will not be inclusive.

When this will impact:



Where this will impact:



71. Challenge

Emerging point-to-point operators are not subject to the same subsidy schemes and accessibility legislation as taxis, meaning they are not accessible to many people with disability. Without action, people with disability will not share in the benefits of emerging transport modes.

When this will impact:



Where this will impact:



Freight gateways supporting international trade

72. Opportunity

Growth in Asia and an increasingly globalised economy means the volume and value of Australia's trade is increasing. Enhancing, adapting and realigning freight networks will allow Australian producers to capitalise on opportunities presented by growing global markets, and Australian consumers to access imported goods as cheaply as possible.

When this will impact:



Where this will impact:



73. Challenge

Charges for truck and train operators accessing our major ports have increased and could be passed on to customers. It is challenging for governments to know if and when a regulatory response is required. Stevedores may have the ability to continue increasing charges, which may lead to growing costs for Australian exporters and consumers.

When this will impact:



Where this will impact:



74. Challenge

Our major container ports are becoming more productive, but continue to lag behind our trading partners for key indicators. Our ports will need to continue to improve to ensure Australia is globally competitive. Without improvement, our ports will continue to be uncompetitive, potentially increasing the time taken to import and export goods and add to costs for Australian exporters and consumers.

When this will impact:



Where this will impact:



75. Challenge

The need to balance passenger and freight services, operating restrictions and constraints on airport land and surrounding roads reduces the efficiency of our airports. The efficiency of our airports could decline further as demand grows, potentially leading to delays and higher costs for high value, time sensitive air freight and passengers.

When this will impact:



Where this will impact:



The urban freight challenge

76. Challenge

Conflict between land uses, particularly in the inner areas of our fast-growing cities, decreases the efficiency of our urban supply chains, particularly warehousing. Conflicting demand for land is inevitable, and governments face a challenge in balancing the needs of different parties. Failure to address land use conflict will result in more operating restrictions on key facilities, inefficient layout of facilities, and additional freight trips on out transport networks.

When this will impact:



Where this will impact:



77. Challenge

Freight transport in our fast-growing cities is impacted by congestion leading to increased costs. If this is not addressed, delays in our urban supply chains will become more common and costs will increase as our cities grow.

When this will impact:



Where this will impact:



78. Challenge

An increase in deliveries by light commercial vehicles is contributing to road and kerbside congestion, particularly in inner urban areas. This is driven by growth in online shopping and changing consumer expectations about timely and door-to-door deliveries. Without action, light commercial vehicles will make a growing contribution to congestion in major employment centres.

When this will impact:



Where this will impact:



Ensuring the national freight network is effective and efficient

79. Challenge

Inconsistent regulations, standards and technologies across our road and rail networks increase costs for transport operators and agricultural producers, which are ultimately passed on to customers. Without action, costs and time spent complying with regulation will remain unnecessarily high, reducing the productivity of our supply chains.

When this will impact:



Where this will impact:



80. Challenge

High productivity vehicle use is limited by community sentiment as well as physical and regulatory impediments to access to our road network. Restricted use of high productivity vehicles will lock in high freight costs for businesses and consumers, and limit benefits to road safety, air pollution and amenity.

When this will impact:



Where this will impact:



81. Challenge

The pace and impact of technological change on our supply chains is uncertain. Governments face dual challenges of enabling private sector innovation while also regulating to ensure change does not harm the community. If governments do not intervene appropriately, innovation could be stifled or, alternatively, technological development could pose safety and environmental threats.

When this will impact:



Where this will impact:



82. Opportunity

New technologies can help improve road safety and efficiency, but they have upfront costs that mean uptake rates remain low. Increased use of technology could improve road safety.

When this will impact:



Where this will impact:



Unlocking regional economic development through freight

83. Challenge

Remote and regional supply chains are critical for industry and to supply communities with basic needs. However, local governments often struggle to fund and maintain critical transport infrastructure. If this is not addressed, our agricultural supply chains and regional and remote communities will be vulnerable to delays, higher costs and extreme weather events.

When this will impact:



Where this will impact:



84. Challenge

The complexity of the freight sector means leveraging infrastructure investments to maximise regional development can be challenging. Without improved coordination between jurisdictions, infrastructure managers and freight operators, regional development opportunities will be missed.

When this will impact:



Where this will impact:



85. Challenge

Highly variable and seasonal traffic can make investment and maintenance of regional grain railways difficult to justify. This results in bottlenecks, speed restrictions, lower capacities and sometimes line closures. If this is not addressed, producers and transport operators will continue to incur higher costs and delays, particularly in high harvest years.

When this will impact:



Where this will impact:



Transporting, storing and making the most of our waste

86. Challenge

Australia has increasing waste generation, a lack of a mature market for private investment and a reliance on waste export. Without action, our disposal, recycling and transportation of waste will become more costly and environmentally damaging.

When this will impact:



Where this will impact:



87. Challenge

A limited number of new waste facilities and landfill sites have been approved and residential development is encroaching on existing sites. Without action, waste freight will have to transport their loads further from the waste generation point.

When this will impact:



Where this will impact:



88. Challenge

Waste is often transported large distances from where it is generated due to a patchwork of government regulation. Without action, waste will continue to be transported further from the waste generation point adding to congestion and road degradation.

When this will impact:



Where this will impact:



89. Opportunity

There is a lack of a mature market for private investment in recycling and waste disposal. There is a chance to capitalise on increased demand for recycled products and larger economies of scale as waste generation increases. Developing a domestic market could improve recycling rates and the sustainability of Australia's waste disposal.

When this will impact:



Where this will impact:



90. Challenge

A lack of scale and access in remote communities means waste freight is inconsistent and not cost effective for consumers or taxpayers. As our waste generation increases waste services in these areas could become more expensive.

When this will impact:



Where this will impact:



91. Opportunity

Transporting waste can have high impacts on urban amenity. Using new technology could make waste transport more efficient and environmentally-friendly.

When this will impact:



Where this will impact:



Social infrastructure

Health and aged care

92. Challenge

Demand for health and aged care services and infrastructure is increasing due to our growing and ageing population, and rising incidence of chronic diseases. This is placing pressure on already stretched health infrastructure. Without action, our healthcare system will be unable to meet this demand and maintain quality, accessibility and affordability of services for communities.

When this will impact:



Where this will impact:



93. Challenge

The changing nature of health issues are driving up the cost of health infrastructure and services for both governments and users. If not addressed, government funding will become unsustainable and costs will become unaffordable for people, particularly those on lower incomes.

When this will impact:



Where this will impact:



94. Opportunity

New healthcare service models that improve in-home and preventive care can reduce hospitalisations. Embracing new models can alleviate pressure on hospital infrastructure, improving access and service quality for those who need it most.

When this will impact:



Where this will impact:



95. Challenge

Chronic condition, aged and end-of-life care infrastructure is not responding sufficiently to changing preferences for care at home or in community. Without action, this care will not be accessible, dignified, nor person centred for a growing number of Australians.

When this will impact:



Where this will impact:



96. Challenge

Young people with disability are often forced to live in inadequate or not fit-for-purpose facilities, including aged care and mental health facilities, due to a lack of purpose-built facilities for people with disability. If not addressed, young people with disabilities will continue to experience poor-quality care that does not meet their needs, and reduces their quality of life.

When this will impact:



Where this will impact:



97. Challenge

Low service densities can limit the provision of accessible, continuous and quality health care in rural communities and remote areas. Without action, healthcare outcomes for communities in these areas, particularly Aboriginal and Torres Strait Islander peoples, will continue to be adversely affected.

When this will impact:



Where this will impact:



98. Opportunity

Technological advancements are enabling health infrastructure to be more digitally-oriented, from patient care to record keeping and infrastructure management. Embracing new technologies has the potential to reduce time and distance barriers to accessing health care, and improve efficiencies and quality of care.

When this will impact:



Where this will impact:



99. Opportunity

The delivery of new and upgraded major health infrastructure in cities provides the opportunity to co-locate these assets with other services, such as other health services, research, education and community infrastructure. Creating health precincts could enable more integrated health care, with higher quality and greater accessibility for patients, and improve Australia's health research and education capabilities, attracting global expertise.

When this will impact:



Where this will impact:



Education

100. Challenge

Early childhood education services are delivered by a mix of public, private and not-for profit providers, creating fragmented infrastructure delivery and quality. Without action, continued variation in the quality of facilities may create poor educational outcomes for some children, and exacerbate challenges for parents in accessing and paying for services.

When this will impact:



Where this will impact:



101. Challenge

Demand for school infrastructure is increasing in our fast-growing and satellite cities, particularly in the inner city and outer growth areas of fast-growing cities. Without action, increased demand will create overcrowding in schools, and impact the quality of infrastructure and educational outcomes for students.

When this will impact:



Where this will impact:



102. Challenge

Traditional approaches to increasing the capacity of school infrastructure, such as using demountable buildings, are not adequate for the demand projected, nor necessarily appropriate for student outcomes. Maintenance backlogs and space constraints provide additional complexity. Without changes to the way demand is evaluated and new capacity provided, schools in fast-growing cities will be unable to meet growing demand, risking reduced quality of education outcomes for students.

When this will impact:



Where this will impact:



103. Challenge

Schools in some smaller cities, and rural communities and remote areas are facing reduced demand, as populations in these areas decline and age. Without action, these communities will be forced to reduce educational services and infrastructure provision, potentially resulting in fewer resources to provide rich and diverse curricula to students.

When this will impact:



Where this will impact:



104. Challenge

Much of Australia's school infrastructure is ageing and not fit for purpose for 21st-century learning. This includes a lack of flexibility to adapt to new technologies and teaching models, or buildings which are not accessible for all students. Maintaining and upgrading buildings is costly for governments and disruptive for learning outcomes, however without action, Australian schools risk falling behind other countries in preparing students for work and life in the 21st century.

When this will impact:



Where this will impact:



105. Opportunity

School infrastructure can provide essential community facilities and spaces, such as sporting fields and halls, however, access to school infrastructure is often restricted to ensure student safety and reduce maintenance costs for government. Harnessing the benefits of school infrastructure for community use outside of school hours, particularly in fast-growing cities where space is scarce, can improve the efficient use of education infrastructure assets and improve health and social wellbeing outcomes for people.

When this will impact:



Where this will impact:



106. Challenge

Demand for tertiary education infrastructure is increasing, particularly for universities in fast-growing cities, and for vocational training in smaller cities, and rural communities and remote areas. Without action, universities and vocational education facilities will experience overcrowding, impacting on the quality of student outcomes.

When this will impact:



Where this will impact:



107. Challenge

Access to vocational education infrastructure is a challenge in remote areas. Students often have to travel long distances to reach teaching facilities. Without action, reduced access to tertiary education will deliver poorer educational and economic outcomes for communities in remote areas, particularly those with high socio-economic disadvantage who cannot afford to travel and stay in other areas to study.

When this will impact:



Where this will impact:



108. Challenge

Competing priorities are reducing the focus on maintaining ageing assets in tertiary education infrastructure. Without action, students may experience poorer-quality learning outcomes.

When this will impact:



Where this will impact:



109. Challenge

Tertiary education infrastructure is often poorly-integrated with other types of infrastructure, including transport and affordable accommodation. Without action, access to tertiary education infrastructure could be reduced for a growing number of students and employees, impacting more broadly on transport congestion and overcrowding, and potentially increasing costs for students.

When this will impact:



Where this will impact:



Green, blue and recreation

110. Challenge

Investment in green, blue and recreation infrastructure is often not prioritised because the true costs and benefits are not well-integrated into government decision making. Without action, essential green, blue and recreation infrastructure will not be delivered, reducing access for communities to spaces that improve liveability, health and environmental outcomes.

When this will impact:



Where this will impact:



111. Opportunity

Joint- and shared-use of recreation infrastructure can solve space constraints in fast-growing cities, and help to overcome lower demand and funding constraints in rural communities and remote areas. Sharing spaces and facilities can improve access for communities to high-quality infrastructure and bring down costs for users and operators.

When this will impact:



Where this will impact:



112. Challenge

Fragmented governance of green, blue and recreation infrastructure makes it hard to integrate into land-use planning. Without action, a lack of coordination for both planning and data could lead to a loss of critical green, blue and recreation infrastructure and inefficient use of existing spaces and facilities.

When this will impact:



Where this will impact:



113. Challenge

In fast-growing cities, green, blue and recreation infrastructure is highly valued and overused. The high cost of land, operations and maintenance make it difficult to fund the delivery and maintenance of new infrastructure in these cities. Our fast-growing cities risk not having adequate high-quality, accessible green, blue and recreation infrastructure as they grow and densify, particularly in inner-urban areas.

When this will impact:



Where this will impact:



114. Challenge

In areas outside of fast-growing cities, green, blue and recreation infrastructure is often fragmented across multiple assets and expensive to maintain. Lower demand in these areas can make it difficult to fund the delivery, operations and maintenance of new infrastructure. High costs of maintenance for underused assets can create challenges in providing adequate high-quality green, blue and recreation infrastructure to support communities.

When this will impact:



Where this will impact:



115. Challenge

Green canopy cover is increasingly hard to provide in cities as backyards decrease and densification occurs. Without action, access to green space will diminish in our cities, and liveability will increasingly be affected by the urban heat island effect.

When this will impact:



Where this will impact:



Arts and culture

116. Challenge

Investment in arts and cultural infrastructure is often not prioritised because the true costs and benefits are not well integrated into government decision making. Without action, arts and cultural infrastructure will not be delivered, reducing access for communities to spaces which enhance liveability, creativity and help to create a sense of identity.

When this will impact:



Where this will impact:



117. Challenge

Governance of arts and cultural infrastructure is fragmented, resulting in a lack of comprehensive data on the scale and distribution of the sector. Without action, investment in the sector will not be prioritised, leading to poorer accessibility and quality arts and culture infrastructure for communities.

When this will impact:



Where this will impact:



118. Opportunity

Well-integrated arts and cultural infrastructure can enhance the value of other types of infrastructure, such as public transport or green infrastructure. Leveraging investment across other sectors by embedding arts and culture into land use and infrastructure planning will provide greater benefits to communities to access arts and cultural infrastructure.

When this will impact:



Where this will impact:



119. Challenge

The arts and cultural infrastructure sector varies across Australia, making it hard to address local needs, audiences, demand levels and funding. Traditional approaches to planning, delivering and maintaining arts and cultural institutions and programs do not always respond to local needs, requiring new approaches to improve access and quality for local communities and visitors.

When this will impact:



Where this will impact:



120. Challenge

Arts and cultural infrastructure suffers from maintenance backlogs, high costs of heritage maintenance, and space constraints, resulting in assets not being fit-for-purpose. Without appropriate long term planning and funding prioritisation, the quality and accessibility of these institutions for users will diminish.

When this will impact:



Where this will impact:



121. Opportunity

Arts and cultural infrastructure plays a key role in the social and economic empowerment of Aboriginal and Torres Strait Islander peoples. Leveraging investment in arts and cultural institutions to promote the collection and celebration of Aboriginal and Torres Strait Islander arts and cultural materials can provide wider socio-economic benefits to these communities, particularly in rural and remote areas.

When this will impact:



Where this will impact:



122. Opportunity

Digital technology offers new ways to access arts and cultural infrastructure, beyond physical assets. Harnessing technological advances and investing in ongoing maintenance and curation will improve accessibility to Australia's arts and cultural infrastructure, particularly for rural and remote communities located long distances from major institutions.

When this will impact:



Where this will impact:



Social housing

123. Challenge

There are limited pathways for people to move through the housing continuum, particularly from social housing into the private market. Without adequate affordable housing options for people on different income levels, people may remain in social housing for longer, occupying homes that could be provided to people in greater need.

When this will impact:



Where this will impact:



124. Challenge

Australia's social housing stock is not meeting current or projected tenant needs in terms of dwelling sizes and configurations, accessibility and supporting services. Without action, reduced access to adequate and high-quality housing can create adverse impacts on other aspects of peoples' lives, including their health, employment opportunities, educational attainment and broader wellbeing and life satisfaction.

When this will impact:



Where this will impact:



125. Challenge

Australia's social housing asset base is deteriorating and there is an increasing maintenance task, affecting the quality of dwellings. Failure to properly maintain dwellings can exacerbate maintenance costs and create negative health and well-being impacts for tenants.

When this will impact:



Where this will impact:



126. Challenge

Remote Aboriginal and Torres Strait Islander housing is not meeting the needs of communities, due to overcrowding and poor quality dwellings. Inadequate housing exacerbates the health, education and well-being outcomes of Aboriginal and Torres Strait Islander peoples, which are already below those of other Australians.

When this will impact:



Where this will impact:



127. Opportunity

The community housing sector is growing, supporting governments to deliver high-quality services to social and affordable housing tenants. Leveraging further growth in the sector can increase innovation in social and affordable housing delivery and management, and improve the quality of housing services for tenants.

When this will impact:



Where this will impact:



Justice and emergency services

128. Challenge

The location of justice infrastructure assets is misaligned with demand, due to population growth and urbanisation. If left unaddressed, this will result in reduced quality of, and reduced accessibility to our justice services, particularly correctional services.

When this will impact:



Where this will impact:



129. Challenge

Ageing justice infrastructure assets are not fit-for-purpose for changing user demographics and needs. Without changes to the design of justice infrastructure and services provided to adapt to changing types of users and needs, diverse users will experience increasingly poor quality services.

When this will impact:



Where this will impact:



130. Challenge

Our emergency services infrastructure is not adapting to changes in the nature and rate of emergencies. Without action, emergency services infrastructure which is not fit-for-purpose for the changing nature of emergencies will reduce access to life-saving services, particularly in rural communities and remote areas.

When this will impact:



Where this will impact:



131. Opportunity

There is a high level of interdependence between justice and emergency services, and with other sectors, such as health. The changing nature of crime and emergency events provides opportunities to improve coordination across sectors to deliver more holistic, and higher-quality services, and improve accessibility through approaches such as jointly-managed facilities and programs.

When this will impact:



Where this will impact:



132. Opportunity

Digital technology and operational changes are providing 'non-build' ways to improve justice infrastructure efficiency and service quality. Harnessing these advancements can reduce demand on existing physical infrastructure and improve the accessibility and quality of these services for users.

When this will impact:



Where this will impact:



Energy



Affordable and competitive energy

133. Challenge

Transparent and affordable electricity prices are essential to reducing pressure on household budgets, particularly for lower income households. A continued rise in energy bills will place an added burden on many households and may reinforce inequality. Ongoing complexity of bills will add to user costs and frustrations.

When this will impact:



Where this will impact:



134. Challenge

Regaining energy price competitiveness is important for lower business costs and improving productivity of Australian firms. Australia risks becoming uncompetitive in some energy intensive industries due to rising energy costs.

When this will impact:



Where this will impact:



Secure, reliable and sustainable energy

135. Challenge

Balancing reliability and affordability in line with users' willingness to pay will be an ongoing challenge in energy systems with rapidly transforming wholesale and network characteristics. Failure to get the balance right will result in higher costs for users due to inefficient investments, or poorer reliability for users.

When this will impact:



Where this will impact:



136. Challenge

Governments, regulators, operators and service providers need to manage growing risks to Australia's energy systems and fuel sources, including risks from climate change, cyberattack or disruptions to fuel supply. Failure to effectively mitigate against risks to energy services could have substantial consequences for the economy.

When this will impact:



Where this will impact:



137. Challenge

Despite positive progress on the development of a national climate policy, ongoing politicisation of the issue and policy inconsistency between levels of government reduce market certainty. Uncertainty prevents timely investment in long-term infrastructure such as electricity generation and gas pipelines, increasing risks and costs to users.

When this will impact:



Where this will impact:



Transitioning to Australia's future energy fuel mix

138. Challenge

Many major coal generation assets are ageing and approaching retirement. The capacity they provide will need to be replaced. In the NEM, this capacity needs to be replaced or there may be impacts on reliability or competition. In the WEM, where there is overcapacity there may be scope to reduce surplus capacity. In both cases, there is a risk to the order of the market.

When this will impact:



Where this will impact:



139. Challenge

As the penetration of small- and large-scale renewables increases across the network, additional investment in networks and generation will be required to manage reliability and service levels. This will increase capital and operational costs in networks, but will be needed to be maintain balanced supply standards.

When this will impact:



Where this will impact:



140. Opportunity

New forms of large-scale storage are increasingly available, including pumped hydroelectric and battery assets. Introduction of appropriate new firming capacity will complement variable renewable energy bids and aid the transition to the new electricity mix.

When this will impact:



Where this will impact:



Planning for our future energy networks

141. Challenge

Transmission networks need to respond to new generation in areas not currently served or without sufficient spare capacity. The outcome of these decisions will be paid for by users over many years. It is in the interests of users that the transition is efficient and guided by well-targeted investment.

When this will impact:



Where this will impact:



142. Opportunity

Coordinating investment in new generation and network assets in Renewable Energy Zones can promote investment in renewable generation, provide clarity for network investors, and increase scale and lower costs for new generation providers. Optimising investment in Renewable Energy Zones will lead to lower wholesale and network costs for users over time.

When this will impact:



Where this will impact:



New opportunities for consumer choice

143. Challenge

Home solar and storage can help users to save costs and control energy use, but government policies are uncoordinated. Developments in behind the meter energy systems risk leaving some users behind, while uncoordinated policies and subsidies add to costs over the long term.

When this will impact:



Where this will impact:



144. Opportunity

Demand response from users can defer or avoid expensive new electricity infrastructure investment, and better use existing infrastructure. This can save users the passed on costs of higher peaks.

When this will impact:



Where this will impact:



145. Opportunity

Electric vehicles could provide additional storage capacity to stationary electricity systems. There are regulatory and technical barriers to be overcome. This may provide a means of converging stationary and non-stationary energy at household level.

When this will impact:



Where this will impact:



Delivering energy in remote communities

146. Challenge

The costs of serving remote and regional areas remain high, with customers in those areas also often receiving poor reliability outcomes. Poor energy reliability in remote areas undermines quality of life and opportunities for growth and investment.

When this will impact:



Where this will impact:



147. Opportunity

There is an opportunity to leverage new local energy supply solutions that either replace or complement diesel generation in remote and regional areas. This can increase amenity, reliability and affordability for local communities and businesses.

When this will impact:



Where this will impact:



148. Challenge

The current regulatory regime does not optimise emerging opportunities for energy supply to regional and remote communities via stand-alone power systems. Without regulatory reform, rural and remote users may not take up lower cost and more reliable energy solutions, and overall costs may be increased for all users and taxpayers.

When this will impact:



Where this will impact:



Harnessing Australia's energy advantage

149. Opportunity

Australia could develop new industries based on cheap and abundant new sources of energy, including large-scale solar and wind. This could attract energy intensive industries to Australia, or allow export of products with high levels of embedded cheap energy. This may require wider use of existing infrastructure, and new infrastructure investment.

When this will impact:



Where this will impact:



150. Opportunity

Australia could leverage its energy resources to provide global leadership and innovation on energy research and development through its high-quality research and education institutions. New discoveries and lower costs can provide Australia with an advantage on applied energy use, supporting new industries.

When this will impact:



Where this will impact:



151. Opportunity

Australia's regions have significant reserves of onshore gas. However, there are restrictions on accessing reserves across many regions. Unlocking these reserves could provide substantial export growth potential, as well as opportunities for lower prices for domestic users.

When this will impact:



Where this will impact:



Telecommunications



Telecommunications enable productivity and innovation

152. Opportunity

Digital technologies are using telecommunications networks to enhance Australia's economic productivity. Embracing these new technologies can be a source of competitive advantage for Australia and can improve outcomes for users.

When this will impact:



Where this will impact:



153. Challenge

Australia's comparative performance for fixed broadband speeds is poor, and we lag well behind comparable nations. Failure to rapidly improve speeds could be a constraint on boosting productivity and liveability, and attracting businesses that require high levels of digital access.

When this will impact:



Where this will impact:



154. Challenge

Cybersecurity risks, such as data privacy and system resilience, are growing as more Australians use more interconnected digital services. Failure to manage these risks could affect user engagement with new services, and reduce the potential benefits of these services. Network efficiency could also suffer.

When this will impact:



Where this will impact:



The mobile coverage dilemma

155. Challenge

Prioritisation of mobile network upgrades in rural and remote areas creates gaps in crucial areas, such as on productive land and along transport corridors. Failure to deliver services to these areas affects community safety, liveability and productivity.

When this will impact:



Where this will impact:



156. Opportunity

5G technology presents an opportunity for Australia and we are well positioned to embrace it ahead of other nations. Delivering 5G networks will help to accelerate Australia's digital transformation, providing significant benefits to people, businesses and governments.

When this will impact:



Where this will impact:



157. Challenge

5G networks will require substantial new infrastructure, creating both cost, planning and security challenges. In cities, this means retrofitting new cells into existing streetscapes, and in rural and remote areas, this means creating adequate densities and improving coverage beyond that of 3G and 4G. Adequately balancing shared and competing tower and cell sites will affect the scale of investment, and ultimate costs users pay.

When this will impact:



Where this will impact:



158. Challenge

Government needs to balance different demands, including from mobile service providers, to deliver efficient and competitive allocation of radiofrequency spectrum. This will affect the quality and cost of mobile services for users.

When this will impact:



Where this will impact:



Maximising the benefits of nbn investment

159. Challenge

There is an inherent tension between the nbn's strategic goals, requiring potential trade-offs between achieving user outcomes and delivering a return on the capital investment made by taxpayers. If all goals cannot be achieved, the ability for Australians to access affordable and high-quality nbn services may be negatively affected.

When this will impact:



Where this will impact:



160. Challenge

The technology mix for the nbn has diversified, meaning different users will receive different types of connections. This change will deliver varied outcomes for users, and some may shoulder higher costs or receive lower-quality services.

When this will impact:



Where this will impact:



161. Opportunity

Private market broadband and mobile operators are providing competitive services in commercial locations to fill nbn gaps. Leveraging competition can provide greater choice for users, supporting affordable and high quality services.

When this will impact:



Where this will impact:



162. Challenge

A proposed eventual sale of the nbn to the private sector raises challenges in striking the right balance between realising its value for shareholders and achieving long-term goals for users. Decisions about restructuring and sale can affect both short- and long-term service delivery and outcomes for users.

When this will impact:



Where this will impact:



Social inclusion and affordability for telecommunications services

163. Challenge

The quality of telecommunications services varies for different groups across Australia, with digital inclusion lagging for low-income households, people who did not complete secondary school, those aged over 65 and people with disability. Without action, these people will be increasingly excluded from an increasingly digital world, exacerbating disadvantage.

When this will impact:



Where this will impact:



164. Challenge

Telecommunications community service obligations lack transparency, competition and specificity, and are often technology prescriptive. Without action, both taxpayer and user outcomes will be further compromised, and CSOs will not service the locations and communities where need exists.

When this will impact:



Where this will impact:



165. Challenge

In fast-growing and smaller cities, telecommunications services are supported by substantial infrastructure that brings fast speeds and data allowances. Access to these services is unaffordable for some groups and can exacerbate socio-economic inequality.

When this will impact:



Where this will impact:



166. Challenge

In regional centres and rural and remote areas, telecommunications infrastructure often delivers costly services which provide poor connectivity, speeds and data allowances. This means people often require extra equipment, such as devices and other hardware, to access services, or can only access mobile data services. This creates impacts for both businesses and individuals, which can exacerbate spatial inequalities.

When this will impact:



Where this will impact:



167. Challenge

Businesses are increasingly demanding more from telecommunications services to compete in the digital economy, but increased downloads, speeds and storage come at a cost. Higher costs will reduce the ability for businesses to grow and compete domestically and internationally.

When this will impact:



Where this will impact:



Water



Changes facing urban water

168. Opportunity

Imminent renewals of ageing assets bring an opportunity to rethink how water and wastewater services are delivered, and to use technology to improve efficiency and levels of service. Renewals could help to avoid overinvestment in large, long-lived traditional water and sewerage assets, and make the system more adaptable to future trends and shocks.

When this will impact:



Where this will impact:



169. Challenge

The urban water sector faces considerable risks, including the impacts of climate change, population growth, ageing assets, and changing needs and expectations from users. Failure to adequately address these challenges could lead to rising water bills, as well as exposing users to risks of declining service quality and reliability.

When this will impact:



Where this will impact:



Sustainable water for liveable cities

170. Opportunity

In increasingly dense cities, water will need to play a growing role in supporting our cities as desirable places to live, work and visit over coming years. Better understanding water's role in urban environments could enhance quality of life, open new spaces for recreation, natural regeneration and cultural practices.

When this will impact:



Where this will impact:



171. Opportunity

Governments and utilities have not fully explored options for greater efficiency by households and industry, including potable reuse. More efficient household usage and industry service provision could provide substantial benefits for users at low cost.

When this will impact:



Where this will impact:



Water and wastewater in regional and remote communities

172. Challenge

Regional and remote utilities face considerable challenges, including reliance on a single source of supply, limited resources, a lack of scale and unreliable information on services. Failing to adequately address regional water challenges could lead to heightened quality or reliability risks and a deterioration of liveability in regional and remote areas.

When this will impact:



Where this will impact:



173. Challenge

Many regional and remote utilities face mounting costs to maintain, renew or upgrade ageing water and wastewater assets, but have limited funding through grants or revenue. Where funding is provided, it is often inefficient or lacks transparency. Failure to provide sustainable funding could lead to declining reliability and quality for regional customers, heightened risks of asset failure, and a mounting funding backlog.

When this will impact:



Where this will impact:



174. Challenge

Some remote communities, many with predominantly Aboriginal and Torres Strait Islander populations, do not have access to reliable and safe water and wastewater services, while monitoring is often inadequate. Failure to address these issues will erode social and physical wellbeing, reinforce disadvantage, and undermine our national and international commitments and objectives.

When this will impact:



Where this will impact:



Water oversight, regulation and decision making

175. Challenge

Information on water and wastewater services is not nationally consistent, reliable, insightful, or reflective of outcomes that matter to users. Inadequate information undermines effective decision making, hides issues that impact users and limits understanding of the value of water and wastewater services.

When this will impact:



Where this will impact:



176. Challenge

No jurisdiction meets best practice regulation and governance in urban water. Key issues include a lack of focus on user objectives, and limited coordination, accountability and independence of decision making. Issues with urban water oversight ultimately leads to poorer outcomes for users over the long term, and, without action, is likely to lead to rising bills in many areas.

When this will impact:



Where this will impact:



177. Challenge

National objectives have not been updated since the Millennium Drought, despite clear lessons for the water sector during this period, and the need for long-term proactive and adaptive strategies to efficiently meet future needs. Being unprepared for another major drought could lead to reactive expenditure on additional supply assets, adding further costs to user bills and taxes.

When this will impact:



Where this will impact:



Balancing competing needs for water

178. Challenge

Striking an efficient and sustainable balance between competing needs from Australia's water resources has proved problematic. Progress against past reform efforts has been significant but patchy. Failure to strike an appropriate balance in water management can lead to substantial and lasting economic, social, environmental and cultural costs.

When this will impact:



Where this will impact:



179. Challenge

Changes in water demand over coming years could affect economic activity and infrastructure requirements in some regional areas. These changes may be exacerbated in drier years. In communities where there is a decline in economic activity, unemployment could rise and some assets may be underutilised or stranded, reducing productivity and growth.

When this will impact:



Where this will impact:



180. Opportunity

Water infrastructure could help to unlock economic opportunities, supported by evidence-based assessments that take into account potential benefits, costs and risks for industry, local communities and the environment. Further evidence on water-led opportunities could help to identify productive investments that can support growth, employment and broader public benefits.

When this will impact:



Where this will impact:



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1

Introduction

Australia, perennially labelled the ‘Lucky Country’, stands in a position of strength.

Twenty-eight years of uninterrupted economic growth has supported the development of a highly educated population, a robust economy and a diverse culture. Infrastructure has been a fundamental component of this success story, supporting a world-class standard of living that is rightly a source of national pride.

But looking forward, Australia faces an unprecedented period of uncertainty.

The compounding issues of a changing climate, digital disruption, a deepened dependence internationally on trading partners in Asia, and increasing political polarisation within established democratic nations is reshaping global institutions and norms.

Closer to home, population growth, an ageing demographic structure, and the persistent shift within the economy towards services and knowledge-based industries, are fundamentally reshaping our day-to-day lives.

This climate of uncertainty is defined by three interrelated dynamics:

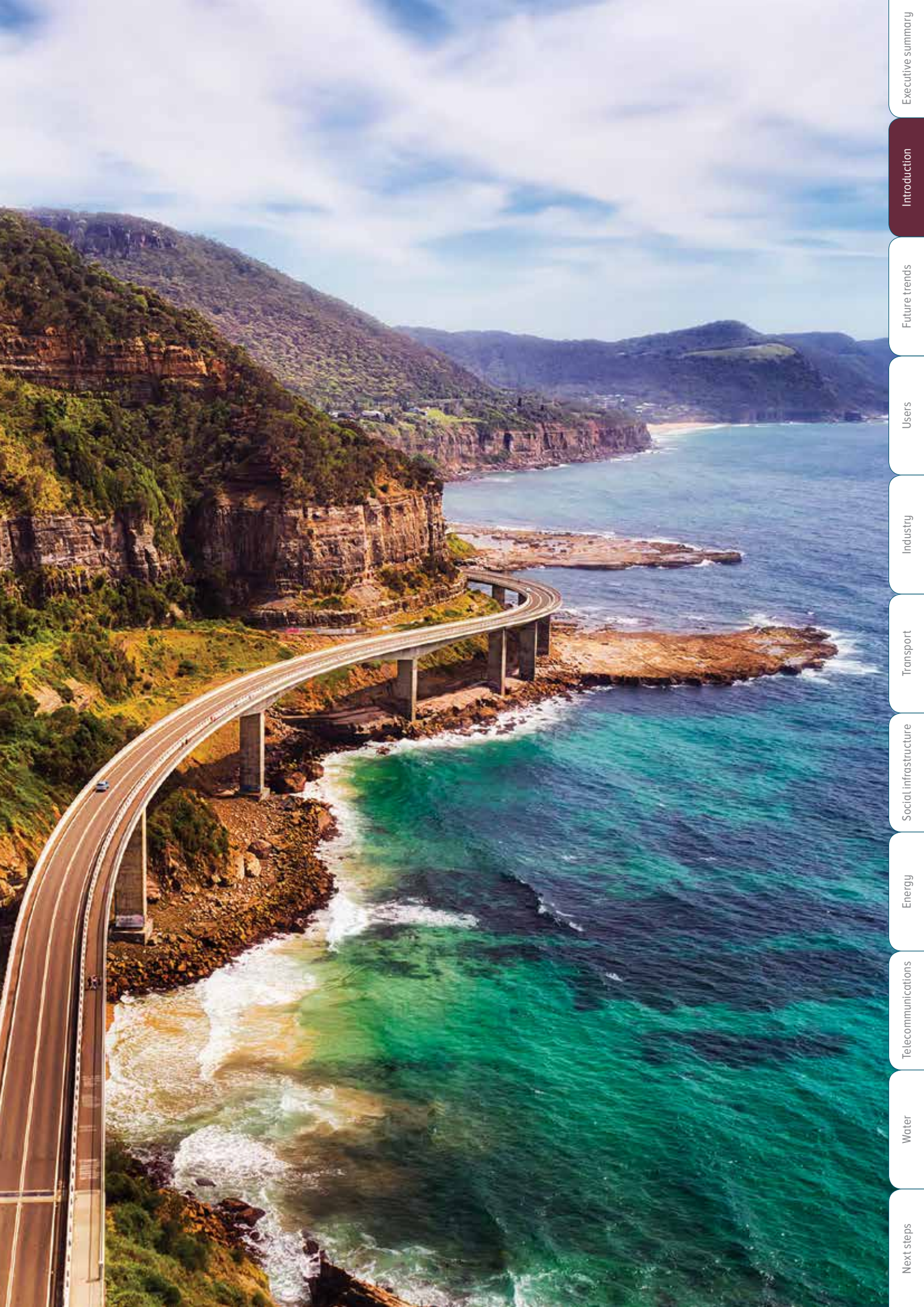
- The rapid pace of change
- Increasing social, economic and global interdependencies
- The proliferation of complex policy challenges.

Together, these have material implications for our infrastructure, which as a result of its nature is delivered over long project gestations and if well designed, and well maintained, will operate for many generations.

Infrastructure is central to our quality of life. It connects us to economic, education and social opportunities. It supports our health, safety and security. It provides us with the essential services we rely on – from energy, water, and telecommunications, to social infrastructure such as hospitals, schools and parks.

But looking to the future, user needs are evolving and in coming decades, our infrastructure will look very different to today. The *Australian Infrastructure Audit* is a timely opportunity to take stock of the most important issues facing our infrastructure as we prepare for a future that is set to be fundamentally different to what we have experienced in the past.







This setting of uncertainty has formed the foundational principle for Infrastructure Australia in developing the Audit. It has provided the lens through which we have assessed the current capacity of our existing networks and assets, and identified the challenges and opportunities the sector faces in the coming 15 years.

Traditionally, an audit is a list of what we know, and some general conclusions about the gaps, perceived or real. This Audit seeks to go much further, and in doing so may challenge some expectations. Our assessment, however, is that the current circumstances call for this approach.

1.1 A future of greater uncertainty

The day to day lives of Australians are changing rapidly

Rapid and frequent change to the way we live, work and do business is an increasingly accepted norm for most Australians. A range of interrelated factors drive the constant and rapid pace of change, including:

- **Rapid developments in technology and science:** In the past century, the pace of technological development and uptake has increased dramatically, fundamentally disrupting basic everyday activities, such as how we communicate, how we get around, how we generate and distribute energy, and how we purchase goods and services.
- **The restructuring of the Australian and global economies:** Our economy is changing. Over the past three decades, the focus of the national economy has transitioned from manufacturing to services and future industry growth is expected across the services, renewable energy, health and aged care sectors. Primary industries will remain important, however globally the growth of the Asian middle class will provide opportunities for a broader range of Australian businesses.

- **Shifting societal demographics and preferences:**

The demographic profile of our population is shifting. The millennial generation is now the largest cohort of the population in terms of size and is increasingly influential. This shift, combined with technology advancement, is driving changes in Australians' preferences. We are leading increasingly connected lives, and displaying preferences for personalised experiences and a broader reflection of values that are aligned with our own.

The pace and scale of change has fundamental implications for how Australia plans for its future. The next few decades are likely to hold more change, and more uncertainty about the nature of that change. In this context, planning for the future requires an understanding of how the world is changing, how our needs are likely to change with it and a level of flexibility in order to adapt to changes that are disruptive and difficult to predict.

The world is more interdependent than ever before

The day-to-day lives of Australians are increasingly interconnected. The rapid uptake of consumer technologies means we can now easily connect to fellow Australians and the rest of the world, with implications for all facets of life, including: access to information and the transfer of ideas, the way we produce and consume goods and services, and the nature and location of our work.

The increasing interconnectedness and globalisation of economic activity means that the performance of our economy is also fundamentally tied to rest of the world. In 2016-17 two way trade in Australia totalled \$735 billion, and accounted for almost 40% of our economy.¹ This will increase, as the growth of the middle class in the Asia Pacific region creates increasing opportunities for Australian businesses.

More broadly, the emergence of complex challenges and disruptive new technologies, has rapidly increased the connections and co-dependency of different sectors of the economy and different parts of the community. The result is that action in one sector or location has increasing implications for another.

These interdependencies have created clear benefits. More than ever before, Australians enjoy greater access to people, products, and ideas. But it has also rapidly increased the complexity of life and the issues we face.

The result is there is an increasing degree of uncertainty about the impacts of decisions and future outcomes, and an increasing requirement for new, more coordinated ways of doing things, which reflect the greater levels of interconnectedness.

Australia faces a complex set of policy challenges

Australia's governments, the private sector and the community are grappling with a uniquely complex set of policy challenges. For example:

- Australia's population is rapidly growing, ageing and urbanising, with implications for the demand for infrastructure and services, and the structure of Australia's economic geography.
- Australia's environment faces a wide range of costs from the impacts from human activity and the effects of climate change.
- Certain groups within the Australian community are caught in a cycle of intergenerational disadvantage.

While challenges like these are vastly different in content and scope, they share common defining characteristics, including:

- Having multiple causes and many interconnections to other issues
- Impacting a wide range of often conflicting stakeholders
- Requiring action within and between many levels of governments, and across the economy, ranging from communities to corporations to individuals
- Having no clear solution and unable to be solved by traditional approaches.²

Complex policy problems themselves are not new but the number and scope of these challenges that Australia, and the world, currently face is unprecedented. The result is that there is a high degree of uncertainty within the Australian community about how and when these issues will be resolved. The scope and scale of these challenges is also calling into question the traditional methods used by governments to address problems and requiring decision makers to adopt innovative, cross-sectoral and flexible ways to find solutions.

We need to think differently about our infrastructure

There is enormous potential for our infrastructure to improve the living standards of each and every Australian. Infrastructure can ease the pressures of growth, catalyse development and enable Australia to compete on a global stage. It can enhance the quality of life of every Australian, and support the growth and success of our businesses. But in the context of increasing complexity, rapid change and growing interdependencies, we need to evolve the way we plan for Australia's infrastructure to embrace uncertainty.

Historically infrastructure planning has sought to predict future conditions and then provide the requisite infrastructure to meet anticipated future demand. Looking to the future, Australia requires a more robust approach. Rather than projecting forward the status quo, our infrastructure planning should enable an ambitious vision for the country, anticipate and adapt to change, manage risk, and deliver infrastructure that improves our quality of life.

Infrastructure Australia has reflected this shift in long-term planning practices, and adopted a methodology that aims to prepare Australia for the future.

1.2 What has changed since the 2015 Audit

Under the *Infrastructure Australia Act 2008*, our governing legislation, Infrastructure Australia is responsible for strategically auditing Australia's nationally significant infrastructure, and developing 15-year rolling Infrastructure Plans that specify national and state-level reform priorities.

Infrastructure Australia's first Audit, released in 2015, was the first national picture of our infrastructure and the challenges it faced. The Audit served as the primary evidence base for the first *Australian Infrastructure Plan*, released in 2016, which provided 78 recommendations for reform, and a range of Reform Series policy papers. The Audit has also provided a point of reference for a range of proposed initiatives and projects on Infrastructure Australia's *Infrastructure Priority List*.

Since the release of the 2015 Audit, a range of national governments have delivered detailed assessments of their infrastructure capacities and needs. These include:

- *Thirty Year New Zealand Infrastructure Plan 2015*³
- *UK National Infrastructure Assessment*⁴
- *Project Ireland 2040*.⁵

There have been major improvements since our last Audit and Plan

Since the release of the first Audit and Plan, Australia has witnessed a number of positive shifts in the way we plan, deliver and operate our infrastructure.

Australia's governments have shown a willingness to drive higher levels of infrastructure investment. Since 2015 over \$123 billion of work has commenced,⁶ with a committed forward pipeline of over \$200 billion.⁷

There has been marked progress in the quality of city and regional planning processes. Increasingly, governments are integrating transport and land-use planning, and have preserved a number of strategically significant corridors for future infrastructure investment. Greater collaboration between jurisdictions has improved the quality of business cases. While, the continued creation of dedicated infrastructure agencies has helped strengthen the national pipeline of infrastructure investments.

At the same time critical regulatory changes have enabled new ways of delivering services in infrastructure markets.

Ongoing challenges need to be resolved

In other key areas, there has been little or no progress against the findings of the Audit and the recommendations in the Plan, and new sector-based challenges have emerged.

In transport, the planned inquiry into road user charging reform is yet to commence, despite support from major road user groups and the inevitability of reductions in revenue from traditional sources of road funding (fuel excise), along with the inequity of the existing charging practice.

Population growth has become a major point of contention in infrastructure debates. Ageing assets have been put under growing strain, with rising road congestion, crowding on public transport and growing demands on social services such as health, education and housing. This prompted the Australian Government to develop a national population policy in 2018, despite having previously rejected the idea when it was recommended in the 2016 *Australian Infrastructure Plan*.⁸

The cost of energy has increased in recent years. A steep rise in network costs has driven energy bills 35% higher over the past decade, and up by 56% per unit of electricity consumed in real terms.⁹ This has eroded some industries international competitiveness and added to cost of living pressures during a period of low wage growth. Despite record investment in renewable energy, the unanticipated closure of large power generators such as Hazelwood has caused uncertainty about network reliability in many parts of the country.

In telecommunications, the National Broadband Network (nbn) has faced issues regarding service quality. In the 4.8 million households in which it has activated,¹⁰ services have not met the expectations of many users. This is particularly true in regional and remote areas that are reliant on satellite services – only 22% of premises that could connect to nbn satellite have done so.¹¹

In the water sector, the past four years has seen mixed results. Many metropolitan utilities are increasing the sustainability and quality of their services through innovation, supporting the liveability of our cities. But many regional areas are suffering from growing water security fears as large parts of the country return to drought. Productive water has assisted strong growth in many agricultural products, but highly publicised failures in the Murray-Darling Basin, including mass fish kills in 2018 and 2019, have eroded public trust in water management and caused substantial harm to natural habitats and areas of cultural significance.

1.3 Objectives of this Audit

The time is right to reconsider how we deliver infrastructure, and how we can adapt existing networks to our changing needs. The *Australian Infrastructure Audit* is the starting point for this process.

The purpose of this Audit is to:

- Draw out the most important issues facing Australia's infrastructure over the next 15 years, and potentially beyond.
- Cover transport, energy, water, telecommunications and – for the first time – social infrastructure. We have taken a wide view of social infrastructure including schools and tertiary education, hospitals and aged care, social housing, justice and emergency services, arts and culture, as well as green, blue and recreational infrastructure.
- Identify challenges and opportunities facing each sector and creates a platform for change.
- Place users at the centre of decision making by considering access to infrastructure services as well as its quality and cost.
- Consider the experience of infrastructure services in different types of communities across Australia.

The challenges and opportunities we identify are a call to action

The role of this Audit is not to present solutions. Before identifying solutions, it is important to have a clear understanding of the problems we are seeking to solve. Infrastructure has the potential to both ease the pressures of growth and provide a catalyst for development. However, in order to meet our diverse needs, we must first be clear on the role that infrastructure plays in each part of the country, and how this needs to adapt over time.

To do this, the Audit identifies issues, gaps, problems and untapped potential in the form of:



Challenges: Where a change in how we deliver infrastructure is required to avoid future costs or erosion of our quality of life or productivity.



Opportunities: Where infrastructure could unlock future growth and development, and improve quality of life or productivity beyond the status quo.

To assist the reader, throughout the document challenges and opportunities are identified by specific icons.

This distinction between challenges and opportunities is important to ensure infrastructure planners and proponents identify and progress infrastructure solutions that not only keep pace with community aspirations and demands, but create the potential to unlock step changes into the future.

These challenges and opportunities should help to guide infrastructure decisions on investments and reforms over the coming years. All require action to ensure Australia's infrastructure continues to support Australian households and businesses, and to deliver improvements in wellbeing.

We aim to engage the community about the future of infrastructure

The Audit is designed to identify those areas that could potentially benefit from reform or investment. The Audit provides perspectives on the most significant issues for the diverse range of infrastructure users across the country. It will be successful if it generates broad community discussion on issues requiring attention and the potential responses to them.

To achieve this, the Audit is drafted to be relevant and easily accessible to a broad audience. This means it is not a conventional audit. We want everyone – from industry experts to members of the community – to be able to access the same evidence and engage in the discussion.

Instead of providing a list of what there is, we seek to:

- Give information about the most significant issues for each sector
- Guide and frame discussions using new evidence and the significant body of research undertaken by others
- Create a platform for the further analysis needed to support decisions.

This Audit supports growth and development in northern Australia

The 2015 Northern Australia White Paper highlighted the immense opportunities for growth and development of our northern regions, across Queensland, Western Australia and the Northern Territory.¹²

Infrastructure Australia supported this work through the 2015 *Northern Australia Audit: Infrastructure for a Developing North*, which took a detailed look at the infrastructure assets and networks that support the north, and how these could be adapted to support growth.¹³

This Audit furthers this agenda by providing updated evidence on the challenges and opportunities of northern regions, and the role infrastructure could play in unlocking their potential. It does so by presenting a single, national infrastructure audit that identifies distinct challenges faced by northern Australia in the areas they are most significant.

Applying this national lens to northern Australia is critical to ensuring that unique challenges of the region are understood as part of the national infrastructure story. There are many similarities in what people across the country tell us they want and need from their infrastructure – physical and digital connectivity, affordability and accessibility of services, and long-term sustainability of their community. But many of the issues faced by northern Australia are distinct from those in other parts of the country, including vast distances between communities, low population densities and extreme weather.

The north also holds many notable strengths, including proximity to growing Asian markets, capacity to grow and untapped resources. Success in these regions can also bring much-needed improvements to the quality of life of many of Australia's most disadvantaged communities, while providing opportunities to celebrate Aboriginal and Torres Strait Islander cultures and support growth.

Being clear on the role of infrastructure in the north will be critical to achieving the vision laid out in the Northern Australia White Paper.

1.4 The approach of this Audit

Infrastructure Australia has taken a new approach to the development of the 2019 Audit.

Infrastructure Australia's first Audit sought to identify the biggest gaps in infrastructure service delivery, and introduced the concept of Direct Economic Contribution as a common measure of scale across sectors.

However, four years on, Australia is facing a very different outlook.

In response, Infrastructure Australia has evolved its approach to the development of the 2019 Audit:

- **The use of Direct Economic Contribution has not been continued.** This decision was based on feedback from our stakeholders. Instead, this Audit relies on conventional measures and existing databases wherever possible, as we seek to provide a broader perspective on Australia's infrastructure, with a balanced assessment of issues and an even weighting across each sector.
- **The 2019 Audit covers economic and social infrastructure.** This allows the Audit to present infrastructure in all its forms for the first time, enabling discussion across the full experience of users, and picking up on all the ways infrastructure shapes our lives.
- **A new three-stage methodology, informed by strategic foresight methods, has been adopted.** Infrastructure Australia has adopted a methodology that considers the broad range of factors influencing the future of Australia's infrastructure and considers a range of outcomes that could result.

The primary differences in approach between the 2015 and 2019 Audits are summarised in Table 1.



Table 1: The 2019 Audit builds on the work from 2015, but also takes a different approach

	2015 Audit	2019 Audit
Format	National Audit, divided by sector (Volume 1) and jurisdiction (Volume 2), and a separate <i>Northern Australia Infrastructure Audit</i>	A single, national Audit, divided by sector and including northern Australia
Metrics	Introduced Direct Economic Contribution to provide a single measure of scale across sectors	Conventional measures of scale and growth
Focus	Networks, assets and cross-sectoral issues	Infrastructure services and user outcomes, focusing on access, quality and cost
Methodology	Analysis-led, drawing out key issues	Theme and issue-led, informed by strategic foresight methods
Outputs	Findings	Challenges and opportunities, including where and when they will impact infrastructure

Methodology

In the context of uncertainty, we have chosen to evolve the way we plan for Australia's infrastructure to embrace this unique setting.

Strategic Foresight is a new field of research that aims to understand the future in a way that does not simply extrapolate past trends to understand the future.¹⁴ Instead, foresight methods use available knowledge and forecasting tools to understand plausible future events and, based on a balanced view of the different futures that may occur, enable robust decision making and investment. This approach is increasingly being used by governments in the United Kingdom, Finland, Singapore, and to a lesser degree Australia, to understand and plan for the future.¹⁵

In developing this Audit, Infrastructure Australia has applied a three-stage methodology, informed by strategic foresight methods, to understand Australia's infrastructure needs in the next 15 years.

Stage 1: Horizon scanning

The starting point for Infrastructure Australia in undertaking this Audit was to understand the national and global forces that are likely shape Australia over the coming years and decades. These trends focus on shifts that are likely to transform how we live, and consequently what we need from infrastructure.

The trends we cover fall under the following categories:

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

These are outlined in the **Future Trends** chapter, and considered in each subsequent chapter.



Stage 2: Interpretation and analysis

The next step was to apply these trends to the sectors of transport, water, energy, telecommunications and social infrastructure, to understand the likely future impacts and needs of these sectors. As part of this process we have applied two sets of lenses to understand future infrastructure needs within each sectors.

1. A focus on user outcomes

This Audit seeks to put users at the centre of infrastructure issues, where they should be, and looks for ways that infrastructure could do more to meet their needs. The user outcomes we have focused on are:

- **Access:** The availability of services for households and businesses, and how easy it is to use them
- **Quality:** The standard of the service provided, covering capacity, reliability, efficiency and customer satisfaction
- **Cost:** The total cost impact on users, including upfront and ongoing charges for users, as well as the draw on taxpayer funds.

2. Impacts on different types of communities across Australia

Rather than adopt conventional state and territory boundaries, we have framed infrastructure needs by the type of community or area they serve. Sydney and Melbourne, for example, share more in terms of their infrastructure needs than Sydney and Broken Hill. We consider it more useful to group Broken Hill with cities of a similar scale, that share similar characteristics, and which play a similar role in their regions, such as Mount Isa and Kalgoorlie. Over time, cities could move between categories as their size and role change.

This Audit divides the country into four broad categories, each including different types of settlements:

1. **Fast-growing cities.** Large cities with dynamic economies, heavily connected to other major cities in the Asia-Pacific region, and with higher than average population growth, including:
 - *Major capitals:* Sydney, Melbourne, Brisbane and Perth.
2. **Smaller cities and regional centres.** Cities with economies that are largely dominated by a few industries and that typically provide a range of important services to their surrounding regions, including:
 - *Smaller capitals:* Adelaide, Canberra, Hobart and Darwin
 - *Satellite cities:* Cities within commutable distance of fast-growing cities, for example: Wollongong, Geelong, the Gold Coast and Mandurah
 - *Regional centres:* Cities that are home to more than 10,000 people (5th to 101st largest cities in Australia).¹⁶
3. **Small towns, regional communities and remote areas.** Smaller communities and townships that provide only smaller scale services, and are typically reliant on larger centres in their region, as well as the vast expanses outside of these communities, including:
 - *Small towns:* Centres with populations of fewer than 10,000 people and more than 200 people
 - *Regional communities:* Settlements with fewer than 200 people
 - *Remote areas:* All areas outside of recognised settlements, including connecting infrastructure.

The Audit also includes a focus on regions that have the potential to grow and develop through specific policy- or industry-led initiatives. These overlap with the geographic categories and include:

4. Developing regions and northern Australia.

The Audit has identified prioritisation from policy makers and past development of these regions can impact on the path of their development:

- *Developing regions:* Regional areas with strong growth prospects, driven by growing demand for the resources and services it produces – or could produce – and which may require changes in infrastructure to help unlock this potential
- *Regions in transition:* Regional areas where industry composition is changing, leading to evolving infrastructure demands to ensure long-term prospects for employment and development
- *Northern Australia:* These include a mix of regions across the Northern Territory, and the northern parts of Queensland and Western Australia that were identified in the 2015 Northern Australia White Paper.

In order to support readers of the Audit, specific icons are used to identify relevant challenges and opportunities for each geography.

Stage 3: Identifying challenges and opportunities

Based on this analysis, the Audit has identified a set of sector-based and cross-sectoral challenges and opportunities, which are issues, gaps, problems and untapped potential where infrastructure can play a role in improving Australians' lives and growing our economy.

For each challenge or opportunity, the Audit provides an estimate of when each will impact infrastructure services and users if no action is taken. Some may have a lasting impact, while others may only have an impact in the short or long term. These categories have been divided as:

- **Immediate term:** 0–5 years
- **Short term:** 5–10 years
- **Medium term:** 10–15 years
- **Long term:** 15+ years.

This reflects when impacts will take hold – not when action is required. Recommendations for appropriate action and their timing will be included in Infrastructure's Australia's next *Australian Infrastructure Plan* and *Infrastructure Priority List*.

These timing categories have been given specific icons, which are used throughout the document, in order to assist readers to identify relevant challenges and opportunities.

We have relied on existing evidence where possible

A national picture of our infrastructure can never be comprehensive or complete.

- There is no single source of data on the current and future performance of our infrastructure networks and assets. Instead responsibility for generating and updating data is fragmented across a huge range of public and private sector institutions, who are each focused on a sub-section of infrastructure, and who each adopt different methodologies.
- There are clear gaps in the data that is available. Some parts of the country – particularly regional and remote areas – are not covered with great detail or clarity by existing datasets.
- Other forms of data need to be updated with more current information, and new or updated information becomes available every day, reflecting continuous changes in how services are being delivered and monitored.

Given these challenges, Infrastructure Australia has not sought to create a new single evidence base to support the analysis of the Audit. Instead we have drawn data from the tremendous knowledge and expertise among the agencies and Australians who plan, build, operate and maintain our assets and networks.

Where clear and reliable evidence exists, our aim has been to build on this work, rather than compete with it. While there are gaps in information in some sectors such as urban water, in other sectors such as energy, several agencies provide extensive data. In these cases, the role of the Audit is to draw out information in a way that reflects user experiences and identifies where there is a need for further attention.

We have commissioned a range of supporting papers to supplement the Audit evidence base. These are published on our website. These include:

- **Community perceptions of infrastructure:** Results from a survey of 5,000 Australians, which measured their views of infrastructure access, quality and cost and whether they have seen improvements or are likely to see improvements in these services. This survey also explored a range of topics related to infrastructure, including community views on population growth in their area, community consultation and planning processes.

- **Costs and affordability:** Measurement of infrastructure costs across all sectors, tracked over time, and expressed as a proportion of average household incomes across Australia.
- **Transport modelling:** Results from transport modelling for 2016 and projected to 2031 across road and public transport networks, with measures of access including to jobs and to social services for Australia's six largest urban regions (conurbations): Sydney, the Hunter and the Illawarra, Melbourne and Geelong, Brisbane, the Gold Coast and Sunshine Coast, Greater Adelaide, Canberra and Queanbeyan, and Greater Perth.
- **Urban transport congestion and crowding:** Drawing from the transport modelling analysis, as well as other sources of evidence, Infrastructure Australia has developed a report that presents a national picture of urban transport networks, drawing out specific points of congestion and strain that will likely need to be addressed through investment or reform.
- **Community services obligations:** A national summary of subsidised funding arrangements for infrastructure across transport, energy, telecommunications and water infrastructure. This measures the value of these community service obligations, as well as their purpose and transparency.

Infrastructure has developed new tools to enable the visualisation of the data we have used to inform the Audit. This data includes online mapping, using the National Map, and an online dashboard and chart builder, all available at our website. These new tools showcase the evidence presented in this Audit, as well as a number of other pieces of research developed by and for Infrastructure Australia.

It is important to acknowledge that there are gaps in the data presented in this Audit. Our intention is to help plug these gaps over time, and to ensure the Audit reflects the full experience of infrastructure users across the country, and speaks in terms that matter to them. Over time, we hope the map and dashboard will be further developed to reflect a deepening, updated evidence base that will provide a point of reference for those in infrastructure sectors and the broader community.

1.5 How this Audit should be used

The *Australian Infrastructure Audit* should be used by a range of stakeholders to support long-term planning, inform better decision making and encourage robust engagement with the future of Australia's infrastructure.

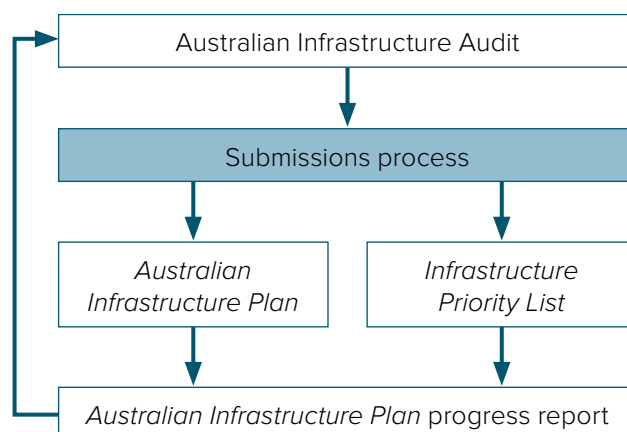
The document provides decision makers in government and industry with a serious evidence base of the challenges and opportunities facing our infrastructure. It should be used to inform their investment and reform decisions, and in turn deliver better outcomes for all Australians.

This Audit gives guidance to the community on the key issues likely to impact the quality, accessibility and cost of the infrastructure they use in their day-to-day lives. As such, it provides Australians with a new tool to understand the trends that are shaping our nation, and engage with government and industry to drive the infrastructure outcomes that best supports their vision for the future.

Importantly this Audit will also underpin Infrastructure Australia's advice to governments, industry and the community over coming years. This Audit is the starting point for a refresh of Infrastructure Australia's strategic planning framework (Figure 1), which will:

- Set out the ambition for Australia's infrastructure over the next 15 years and beyond
- Identify a package of investment and reform actions
- Set a series of priorities against which our progress is tracked and reported on
- Be an input to the development of the *Infrastructure Priority List* and the assessment of the strategic case for project business cases.

Figure 1: The 2019 Audit builds on the work from 2015, but also takes a different approach





The next *Australian Infrastructure Plan* will consider each challenge and opportunity identified in this Audit that requires action via policy reform. The document will outline our recommendations for reform and where practical set clear targets against which we can measure progress. The *Infrastructure Priority List* will respond to challenges and opportunities that require action via infrastructure investment.

The process does not end there. Once the reform and investment priorities are set, Infrastructure Australia will track and publically report on progress through the *Australian Infrastructure Plan* progress report. A new report building on the objectives of Infrastructure Australia's *Prioritising Reform* report, the *Australian Infrastructure Plan* progress report will track Australia's progress against meeting the reform targets set by the Plan and progressing the potential investments highlighted in the *Infrastructure Priority List*.

1.6 How to read this Audit

The following chapters of the Audit are divided into four sections:

1. **Future Trends:** 2. *Future Trends* identifies the future national and global trends impacting Australia, and our infrastructure, over the next 15 years and beyond.
2. **Cross-sectoral chapters:** 3. *Infrastructure services for users*, and 4. *Industry efficiency, capacity and capability*, bring together the challenges and opportunities that are common across all sectors.
3. **Sector-based chapters:** 5. *Transport*, 6. *Social Infrastructure*, 7. *Energy*, 8. *Telecommunications*, and 9. *Water*, individually identify the challenges and opportunities relevant to each infrastructure type.

4. **Next steps:** 10. *Next Steps* provides information on how to provide feedback on the Audit and contribute the development of the forthcoming *Australian Infrastructure Plan* and the *Infrastructure Priority List*.

The content within each chapter has been structured around key issues. This means that each issue is explored in depth with a series of corresponding challenges and opportunities identified. The identification of major issues allows the consideration of the causes of challenges and opportunities, as well as their impacts on users and communities. Each issue begins with an 'At a glance' box to provide the reader with a quick snapshot of the key messages covered in the forthcoming section.

The challenges and opportunities are interspersed within each theme and listed at the end of each relevant chapter. Each challenge and opportunity includes the following elements:

- A description of the challenge or opportunity which has been written to give the reader a clear sense of what we've found and the implications in terms of the access, quality and cost of our infrastructure for users.
- An icon which denotes whether the findings applies to the geography of fast-growing cities, smaller cities and regional centres, or small towns, remote communities and areas.
- A time scale which shows when the challenge or opportunity will impact infrastructure services and users if no action is taken.

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2

Future trends

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

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

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

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





2.1 Introduction



The future is uncertain

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

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

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



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

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

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

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

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

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



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

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

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

We have identified seven key influences

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

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

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

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

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

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

In this chapter

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

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

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

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

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

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

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

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

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

Quality of life and equity – snapshot

13.9 years

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



In 2018,

Australia ranked 3rd

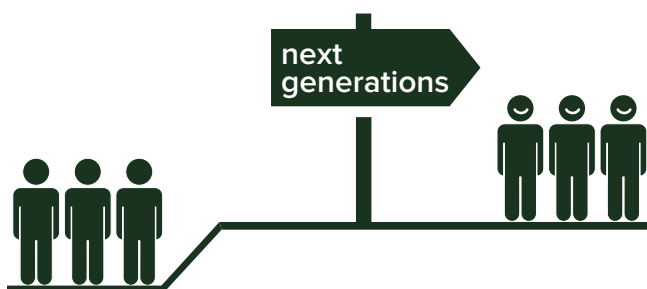
in the world on the UN's Human Development Index ³

Australia ranks 10th

in the OECD for life satisfaction ⁴



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



Australia ranks

31st in the OECD

for work-life balance ⁷

2.2 Quality of life and equity

At a glance

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

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

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

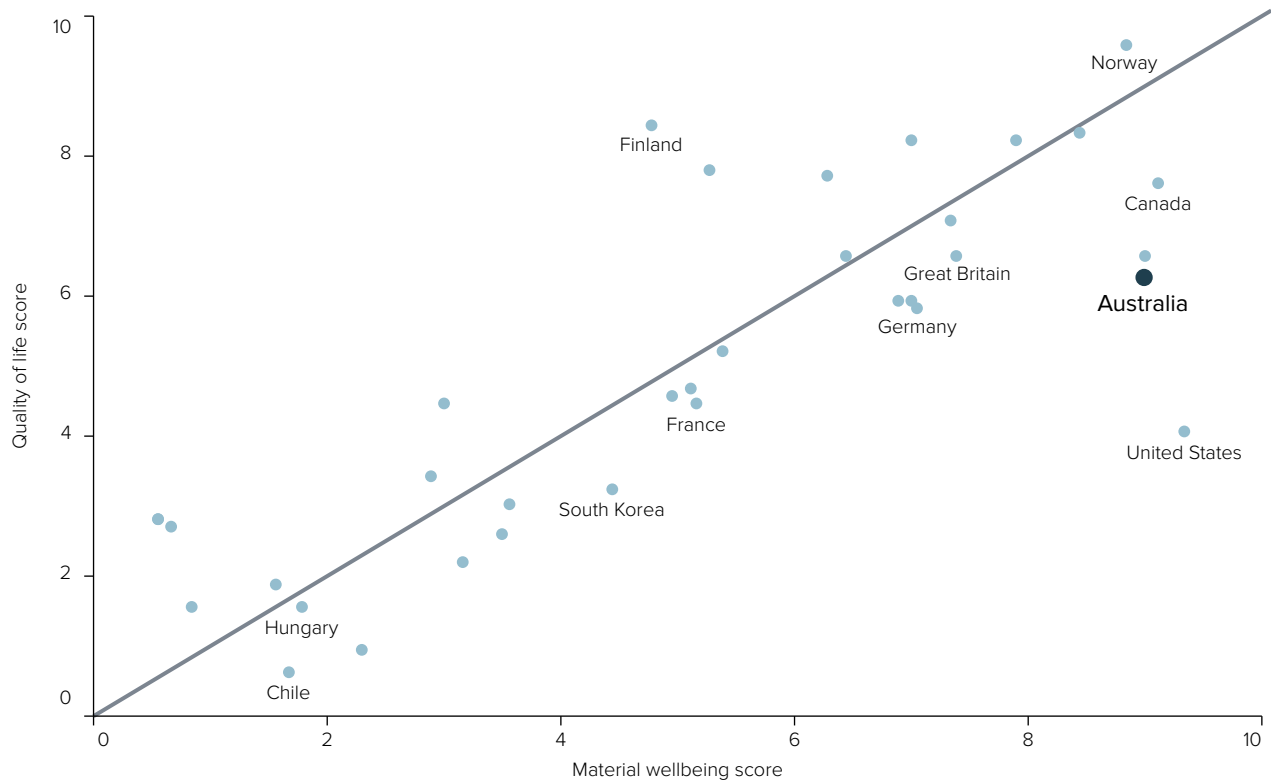
Australia has a high quality of life by international standards

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

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

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

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



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

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

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

Quality of life varies for different people and places

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

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

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

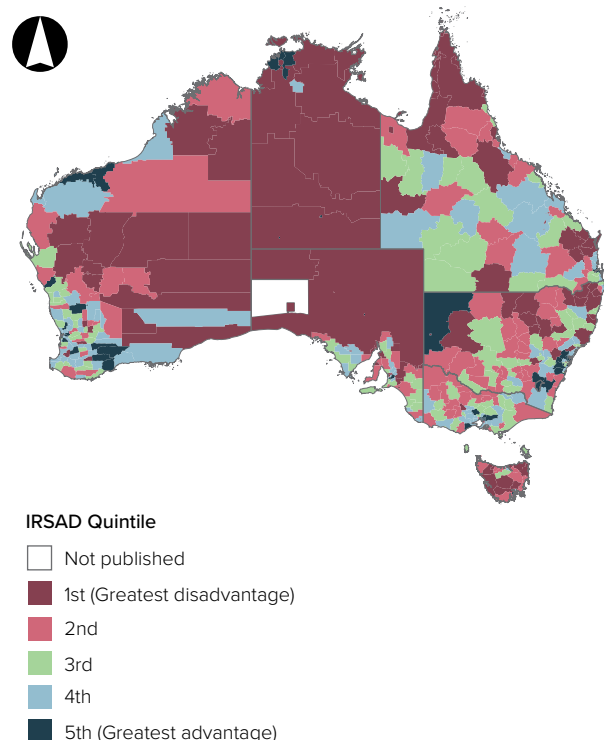
Other trends are placing greater pressure on vulnerable people, and creating issues of intergenerational disadvantage. These include an increasing proportion of older people and older women outliving men, increasing incidence of chronic disease, and housing affordability pressures.

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

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

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

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



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

Source: Australian Bureau of Statistics (2018)²⁵



Global jurisdictions are increasingly prioritising quality of life

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

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

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

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

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

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

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

Cost of living and incomes – snapshot

The richest 20%

of households have five times
as much household income as

the lowest 20%

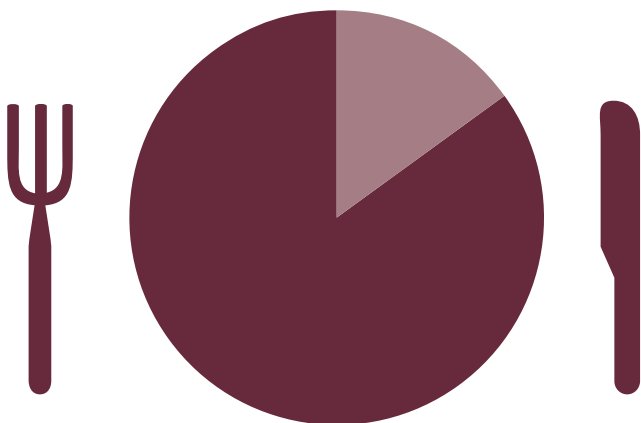
of households ³⁴



Borrowing for housing makes up around

90% of total
household debt

of Australians ³⁵



15%

of Australians
report experiencing
food insecurity ³⁶

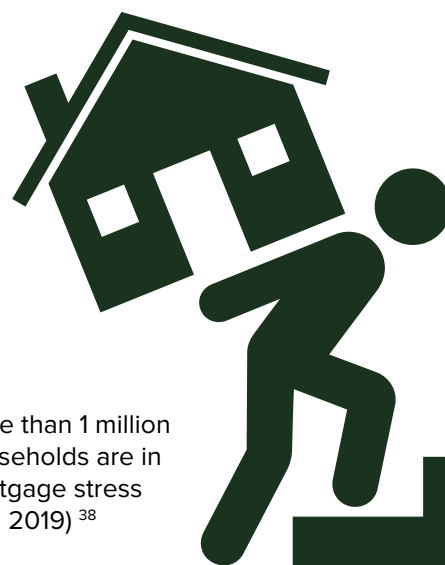
Average wealth of a household in the highest 20% is
100 times that of a household in the lowest 20% ³⁷



In 2017, the poorest 50% of Australians had

3.7%

of national wealth, down from 3.9% in 2007 ³⁹



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

1+
million

2.3 Cost of living and incomes

At a glance

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

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

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

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

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

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

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

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

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

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



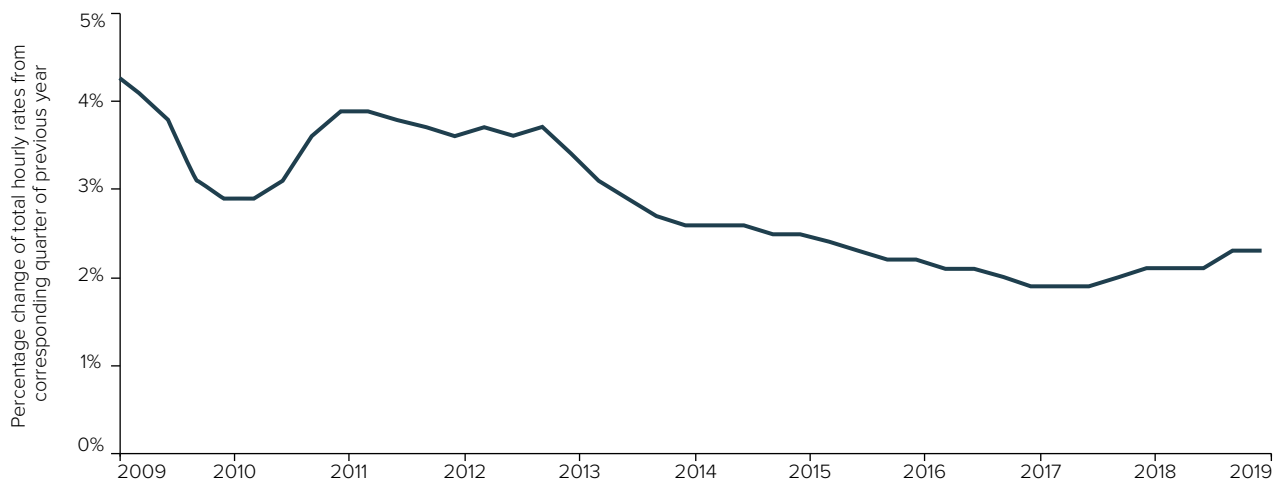
Note: This is drawn from the Melbourne Institute's Household, Income and Labour Dynamics in Australia Survey, which reports Australian Capital Territory and Northern Territory together. Values are inflation adjusted to December 2016.

Source: Wilkins and Lass (2018)⁴⁶

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

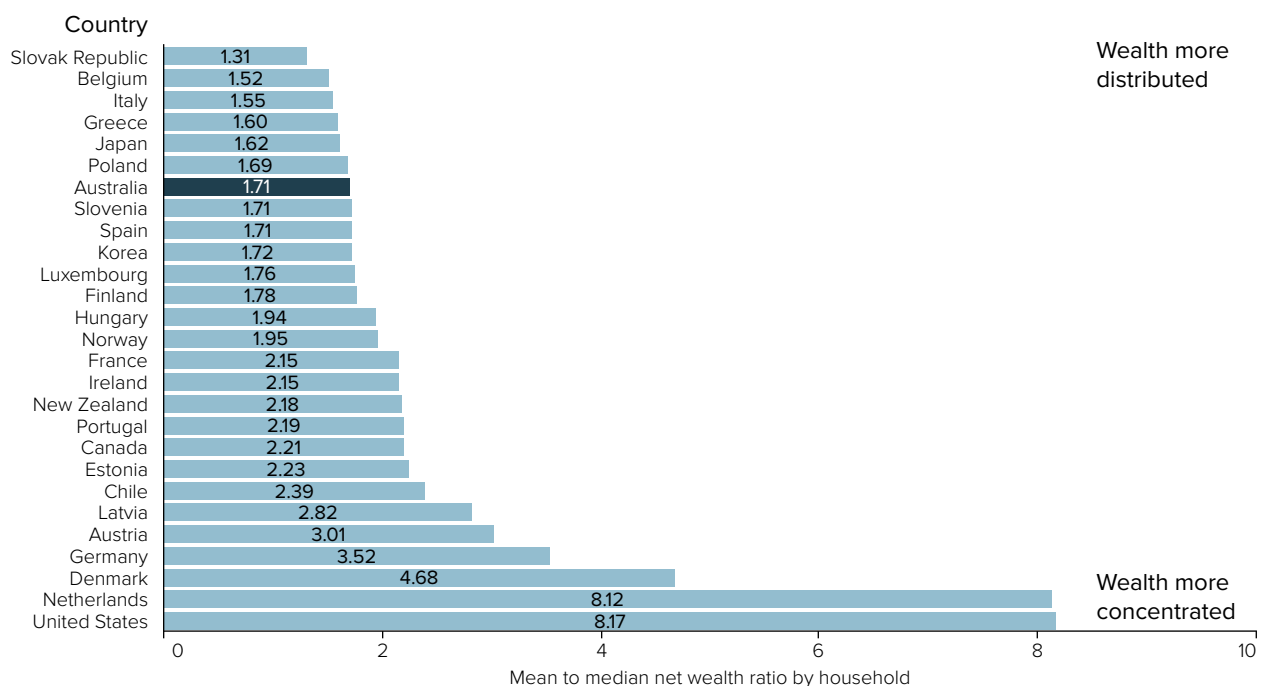
The distribution of wealth across Australian households is far from equal, but the biggest single equaliser is the relatively high level of home ownership in this country. The average wealth of a household in the highest 20% is 100 times that of the lowest 20%,⁴⁷ explained principally by the relative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

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



Source: Australian Bureau of Statistics (2019)⁴⁸

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



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

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

The cost of essential services is increasing

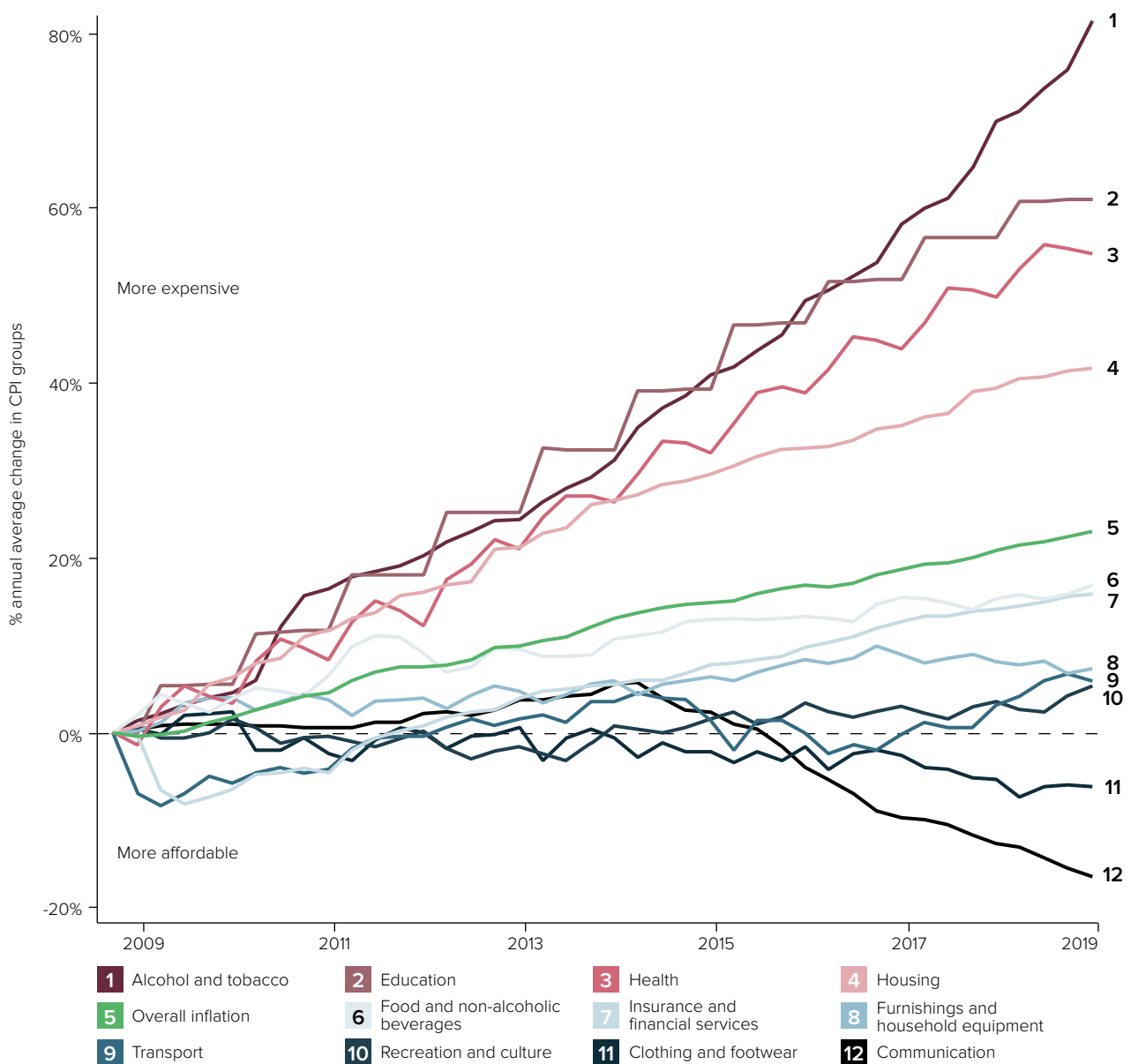
As Figure 6 shows, the total Consumer Price Index (CPI) (shown as overall inflation) has increased at around 2% over the past decade, but has slowed to around 1.5% over the past three years.

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

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

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

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



Source: Australian Bureau of Statistics (2019)⁵²

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

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

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

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

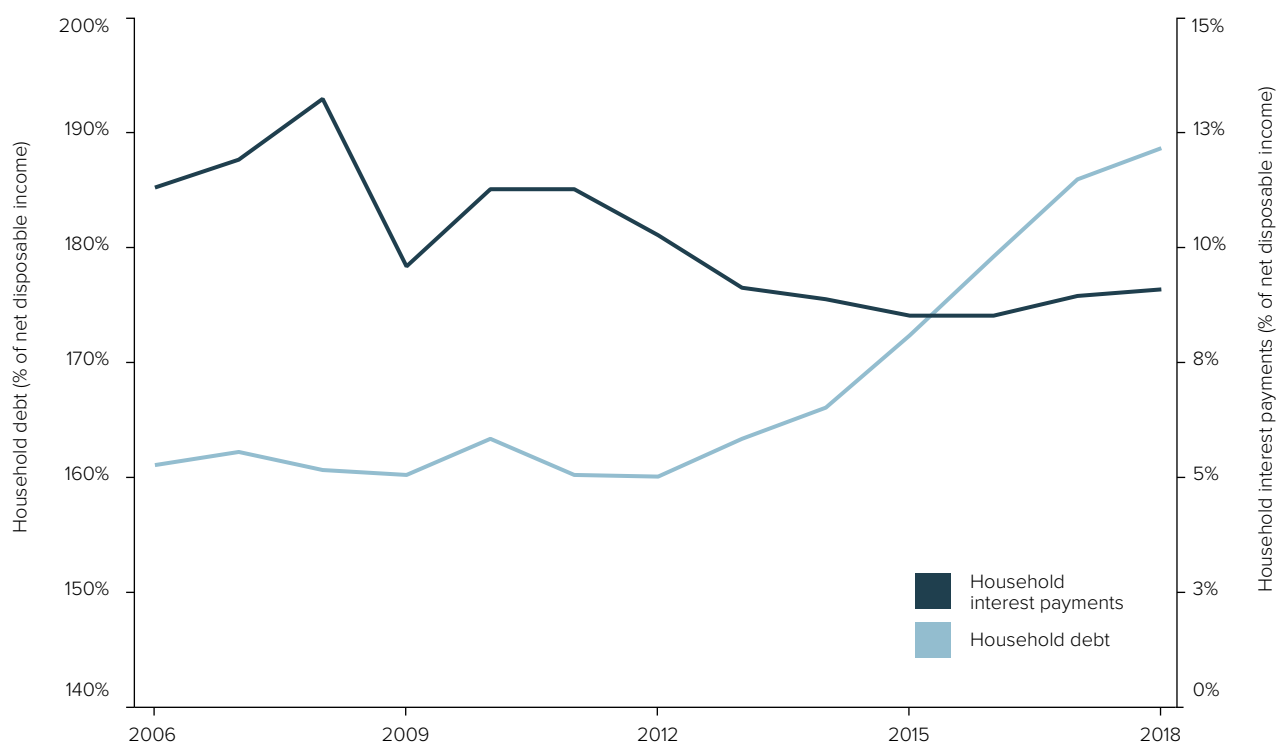
The largest pressure on household budgets comes from housing costs. Longer-term price increases have been driven by, among other things, low interest rates, strong investor interest in housing (partly due to volatility in other investment sectors such as the share market), and growth in population and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

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

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

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

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



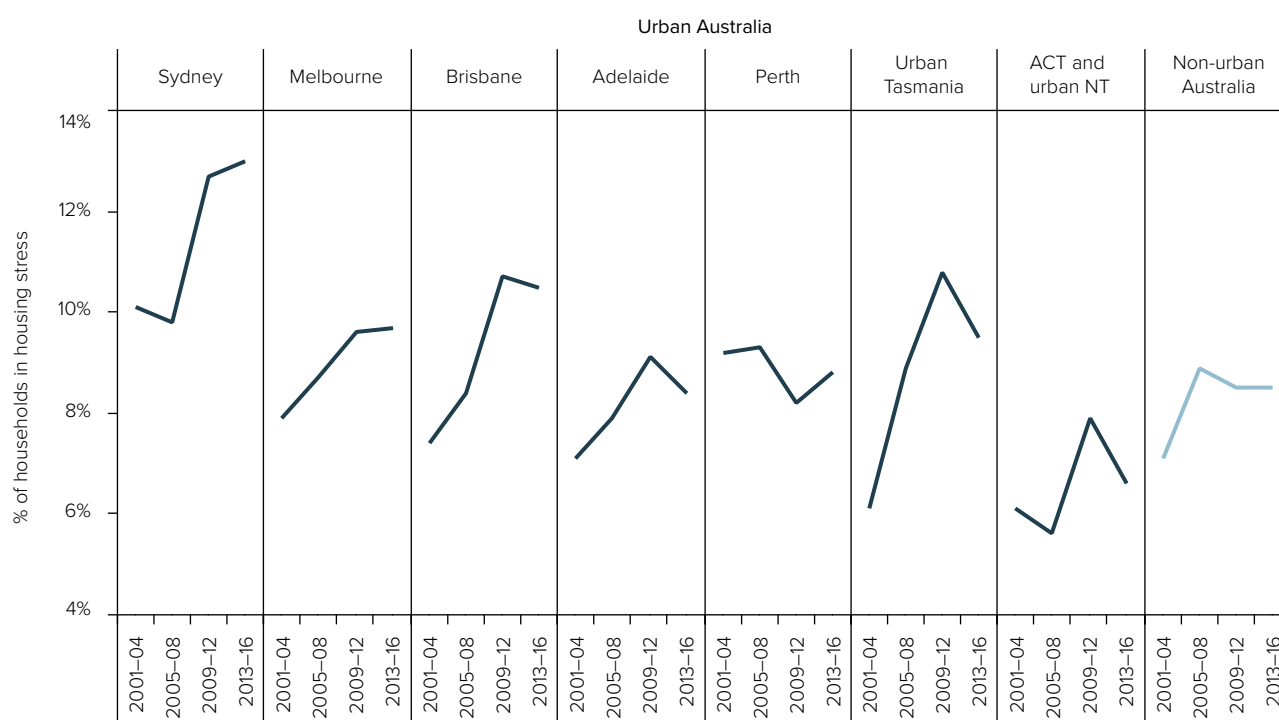
Source: Reserve Bank of Australia (2018)⁶¹



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

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

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



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

Source: Wilkins and Lass (2018)⁶⁴

Community preferences and expectations – snapshot



42%

of Australians have
trust in government ⁶⁵



Airtasker
1.6m
users ⁶⁶

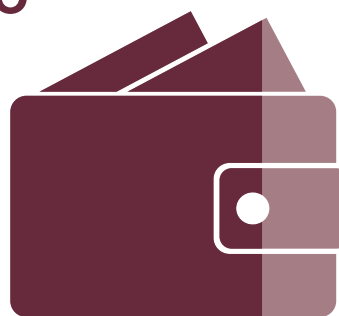


Uber
3.8m
users ⁶⁷

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

75%

25%



70% of
Australians

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

75% of workforce

to be millennials by 2025 ⁷⁰

64%
of Australians

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

2.4 Community preferences and expectations

At a glance

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

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

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

People are placing greater demands on businesses, products and services

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

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

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

Expectations of sustainability, ethical production and wellbeing are increasing

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

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

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

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

Trust in institutions is declining

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

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

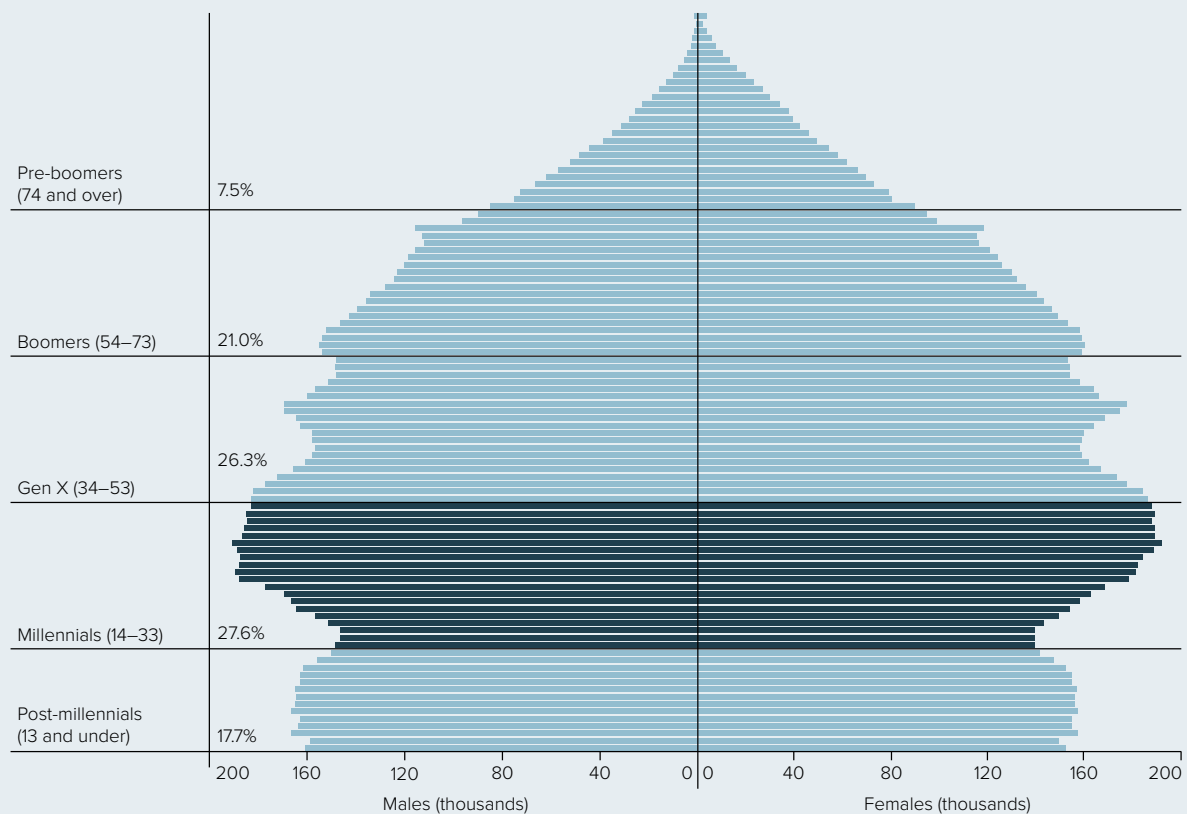
The impact of the millennial generation

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

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

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

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



Source: Australian Bureau of Statistics (2018)⁸⁵

Preferences and expectations are not uniform across Australia

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

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

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

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

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

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

Sharing markets are disrupting existing economies

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

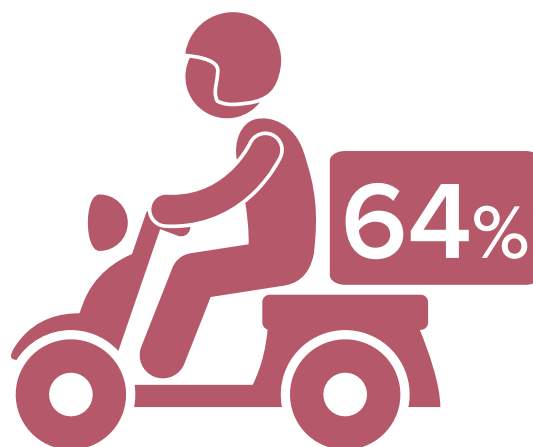
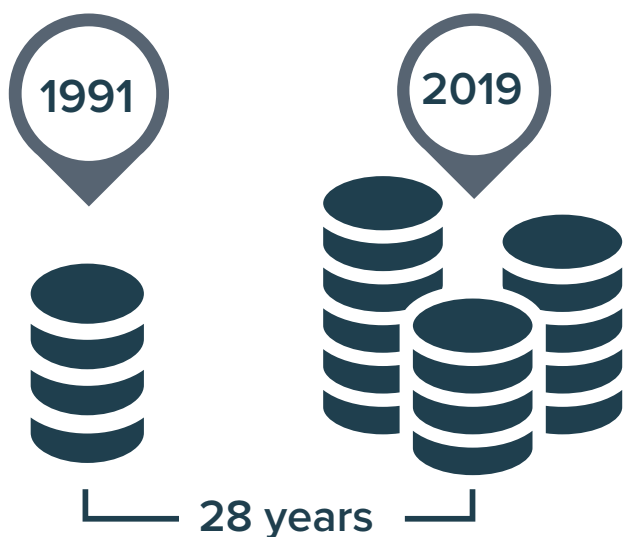
These emerging markets accompany changing consumer expectations of ownership and relationships to products. New markets may benefit consumers in the form of lower-priced or better-quality goods and services. Businesses may also benefit, in the form of lower labour and material costs. While there are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

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

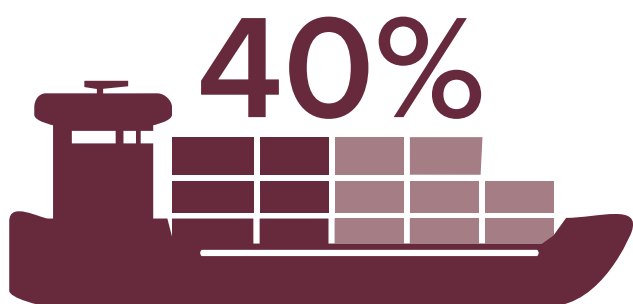
A small but high-profile trend to create personal services from cars (ridesharing), homes (rooftop solar, home sharing), possessions (renting or selling household goods and clothing), skills (providing one-off services to those in need, for example data entry, cleaning or furniture assembly), computing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

Economy and productivity – snapshot

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



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



International trade is almost 40% of our economy ⁹⁶



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



of Australia's economic growth occurred in capital cities between 2000-01 and 2015-16, an average growth of 3.2% per year ⁹⁸



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

2.5 Economy and productivity

At a glance

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

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

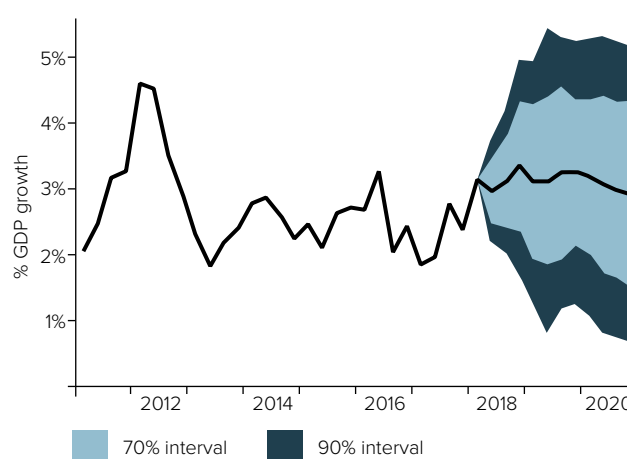
- Our growing population and economy will constrain budgets, but our net debt is relatively low.
- The cost of doing business in Australia is high due to labour, land, energy and regulatory costs.
- The digital economy is changing the way we work, consume and do business.
- Economic activity is urbanising,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

Predicting economic growth is a challenge

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

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

Figure 10: GDP growth is difficult to forecast

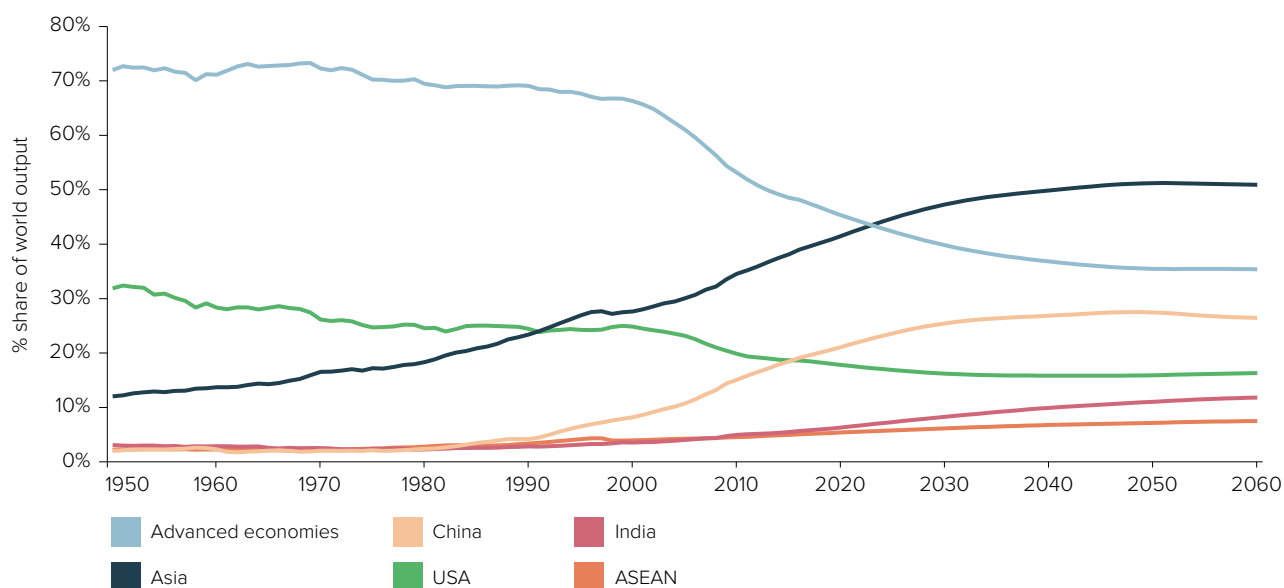


Note: Confidence intervals reflect RBA forecast errors since 1993.

Source: Reserve Bank of Australia (2018)¹⁰⁴

The growth of our Indo-Pacific neighbours presents opportunities

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

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

Source: Australian Government (2015)¹⁰⁶

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

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

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

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

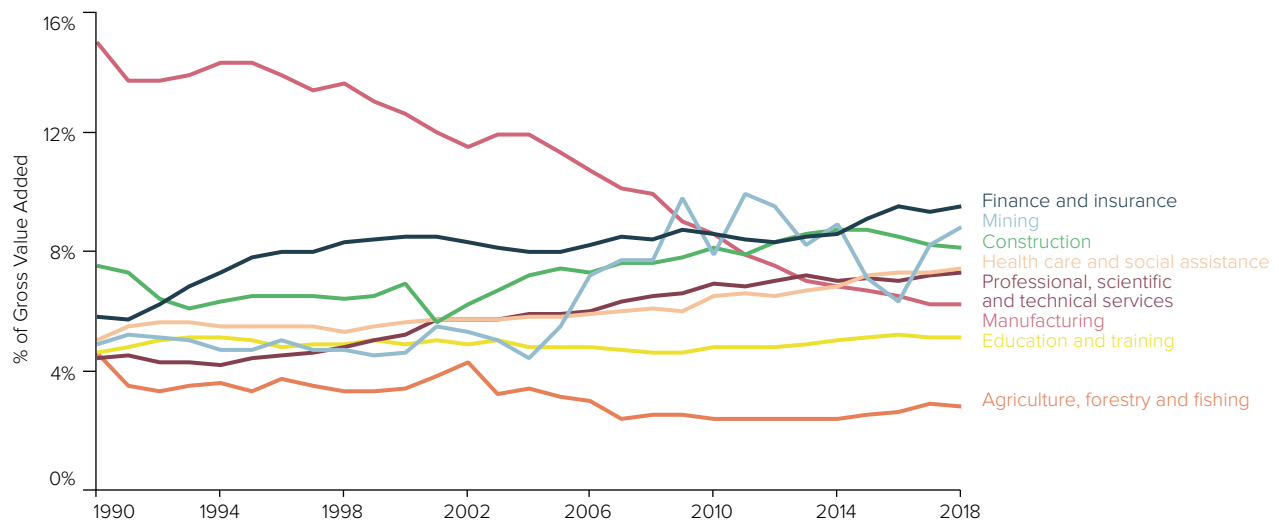
Achieving export diversification and growth will require Australia to change how goods are moved. Reducing freight costs is a challenge – freight costs have not fallen in 25 years, despite infrastructure investment and technological advancements.¹¹⁴ Australia may struggle to continue competing with lower-cost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

Australia's economy is undergoing structural changes

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

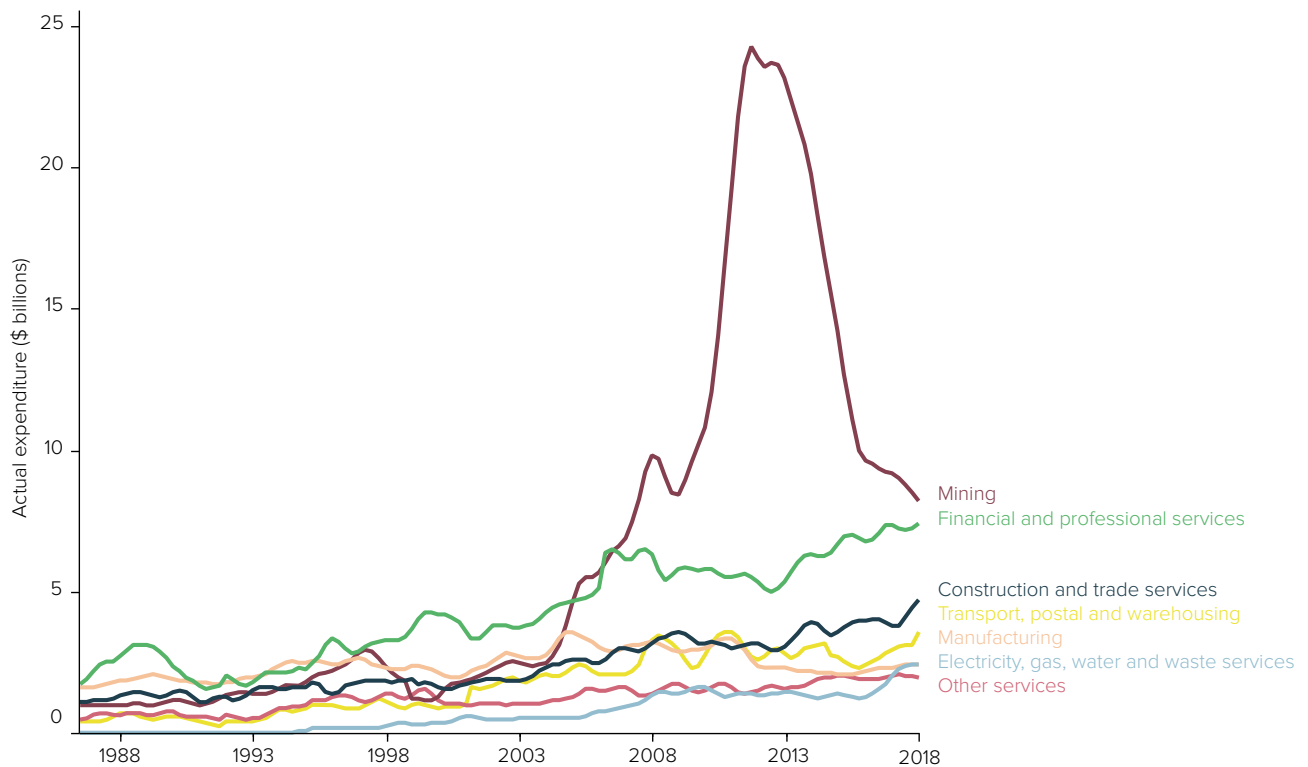
While the mining industry remains the dominant export industry, accounting for three of our top five exports, current trends show a tapering of business investment in mining, which will continue to decrease over the short term (Figure 13). Since the 2015 Audit, the mining industry has begun to shift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

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



Source: Australian Bureau of Statistics (2018)¹⁶

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



Source: Australian Bureau of Statistics (2019)¹⁷

Productivity growth is slowing

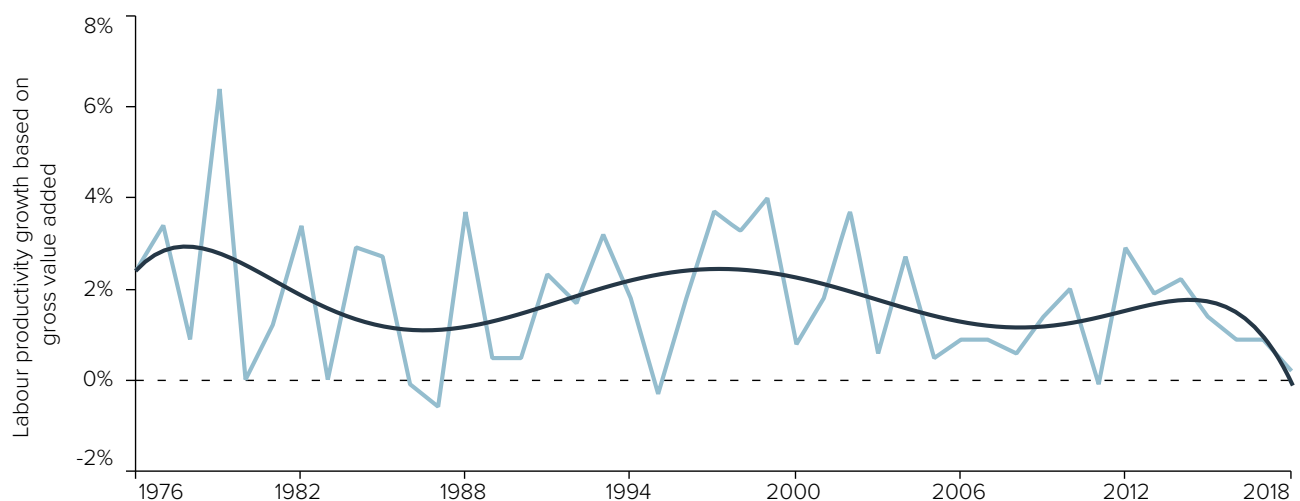
Economic growth is driven by three key components: productivity, population and labour-force participation. Productivity, the ratio of outputs to inputs, measures how efficiently an economy operates. Population and labour force participation are discussed in detail in section **2.6 Population and participation**.

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

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

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

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



Source: Productivity Commission (2019)¹²³

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



Source: Australian Bureau of Statistics (2018)¹²⁴

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

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

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

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

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

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

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

The cost of doing business in Australia is high

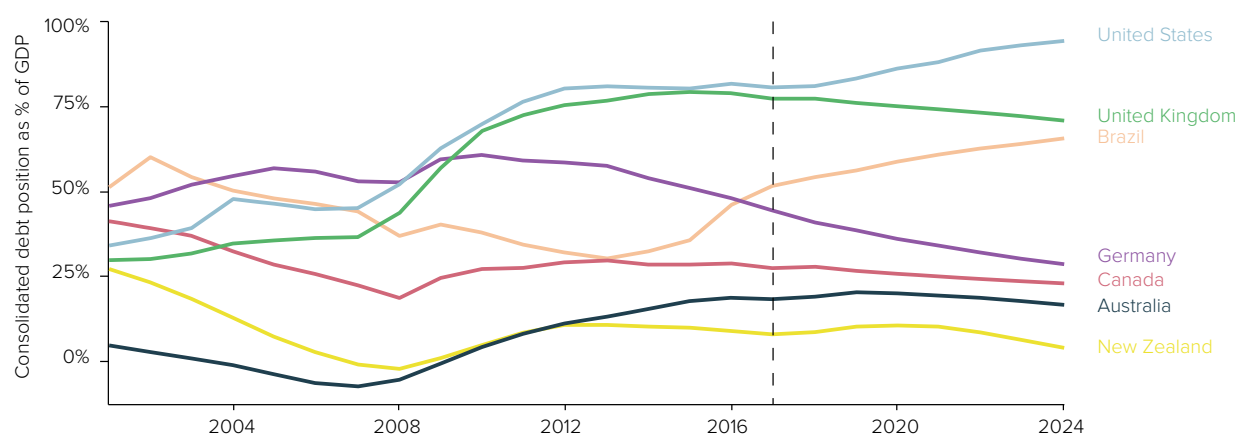
Australia ranks 17th in the world for ease of doing business, behind New Zealand (ranked most business friendly), the United States, United Kingdom, United Arab Emirates, Denmark and Sweden.¹³² We also rank behind our neighbours in Asia, such as Singapore, Hong Kong and China.

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

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

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

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



Source: International Monetary Fund (2019)¹³⁴

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

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

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

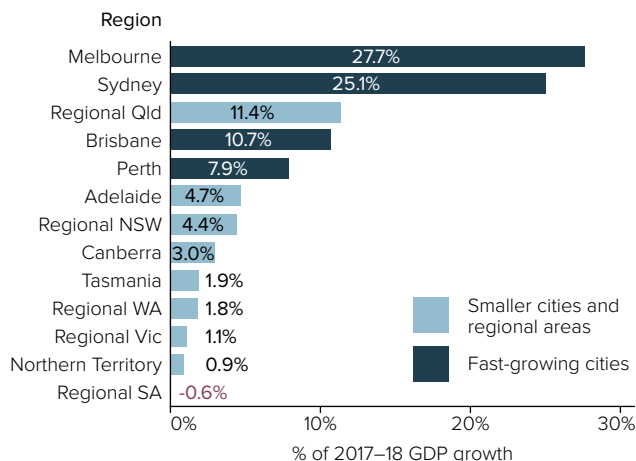
However, the digital economy also brings challenges, as some technologies deliver benefits but with unintended consequences. For example, electronic goods such as smartphones bring huge benefits to Australians and offer new opportunities to address modern challenges. They provide a platform for new tools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

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

Economic activity is urbanising

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

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



Source: SGS Economics and Planning (2018)¹³⁹

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

Australia has a multi-tiered economy:

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

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



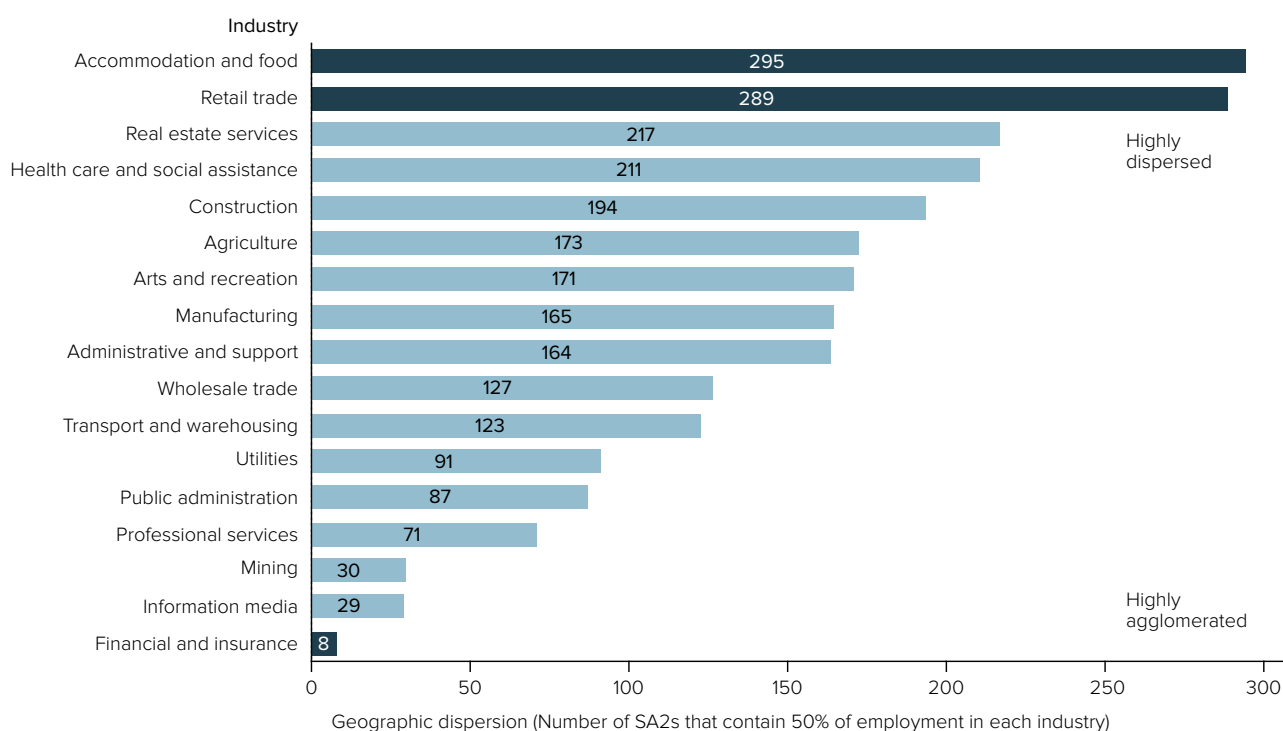
The nature and location of work is changing

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

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

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

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



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

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

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

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

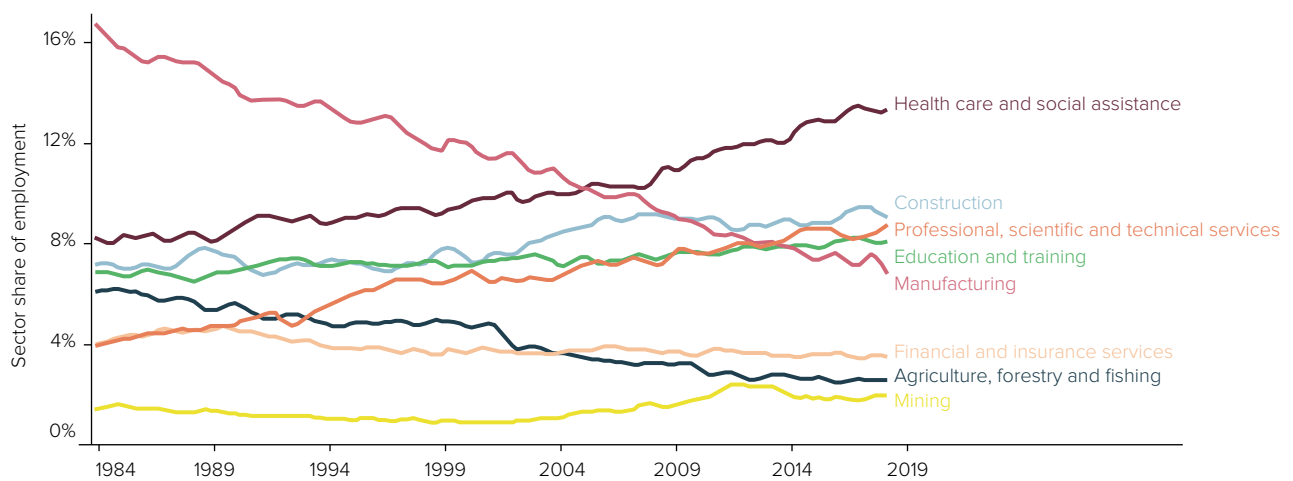
Source: SGS Economics and Planning (2018)⁴²

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

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



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



Source: Australian Bureau of Statistics (2019)¹⁴³

Population and participation – snapshot

National population growth in 2019 is

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



Australia has grown by over

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

Between 2008 and 2018

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



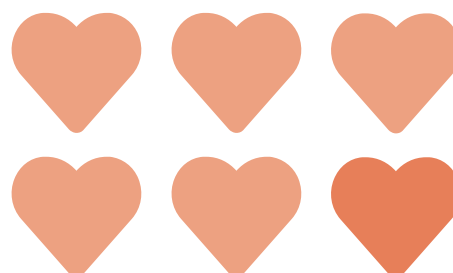
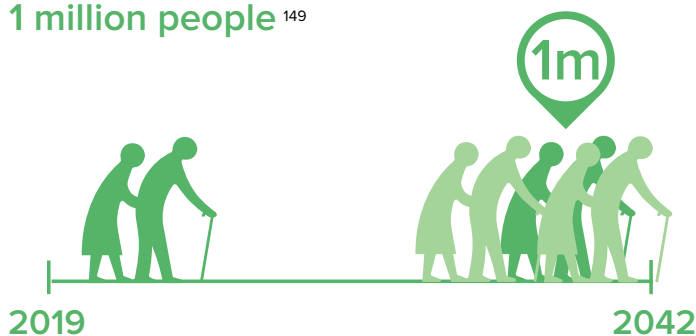
Australia ranks

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



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

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



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

2.6 Population and participation

At a glance

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

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

Australia's population is growing

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

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

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

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

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

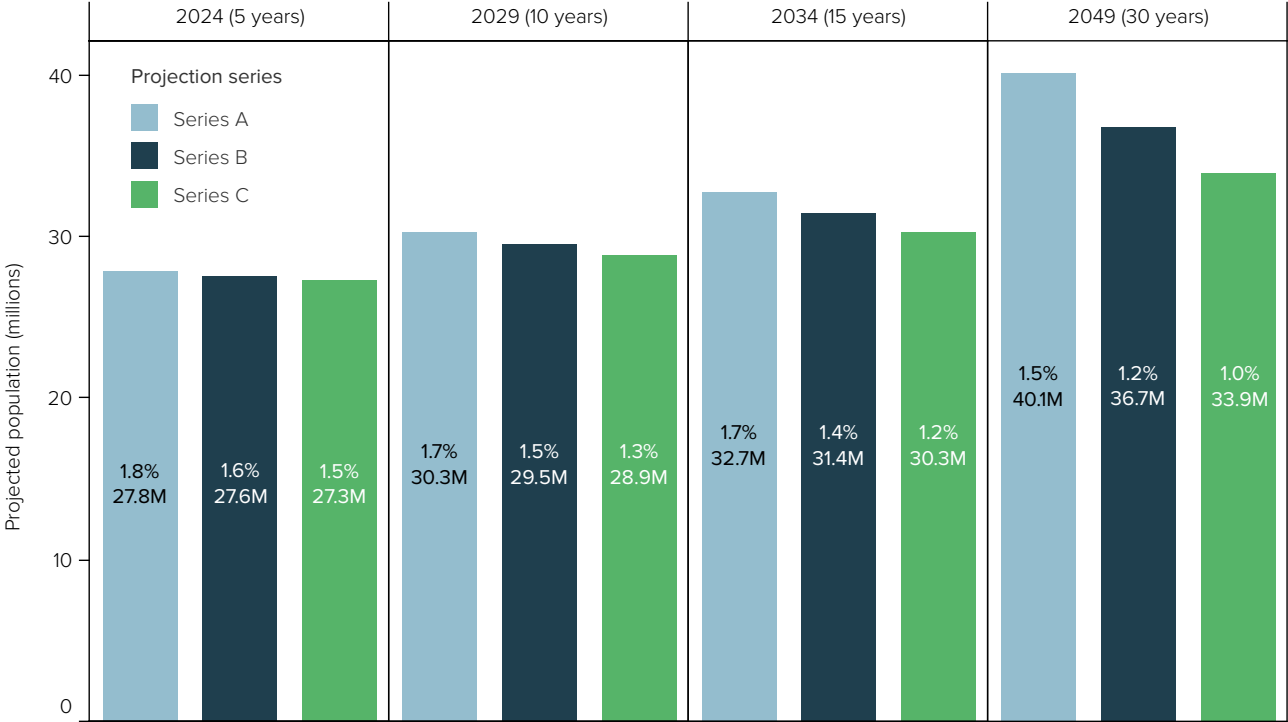
Australia's population composition

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

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



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



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

Source: Australian Bureau of Statistics (2018)⁵⁸

Predicting how we will grow is an inexact science

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

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

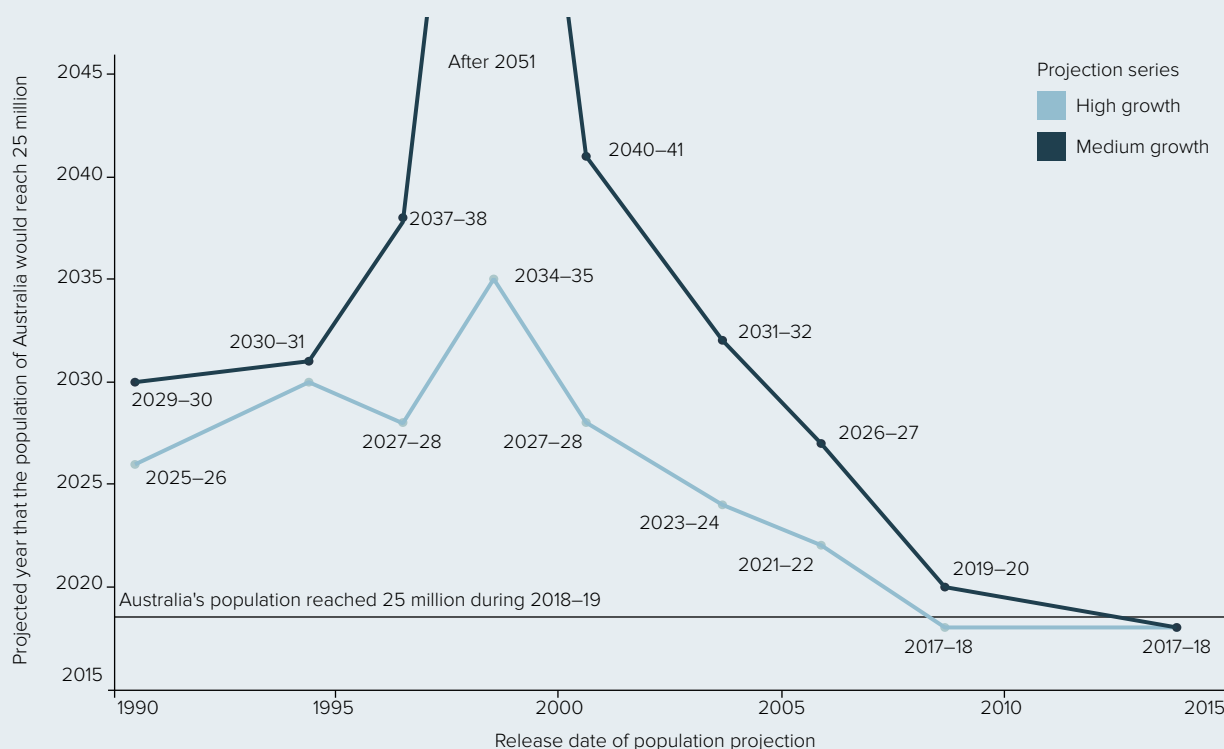
Estimating population growth for small geographies faces similar challenges. Where people live within Australia is influenced by factors such as economic growth and job availability, affordability and lifestyle preferences. These factors can shift over time, meaning people can

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

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

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

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



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

Our population is urbanising and densifying

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

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

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

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

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

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

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

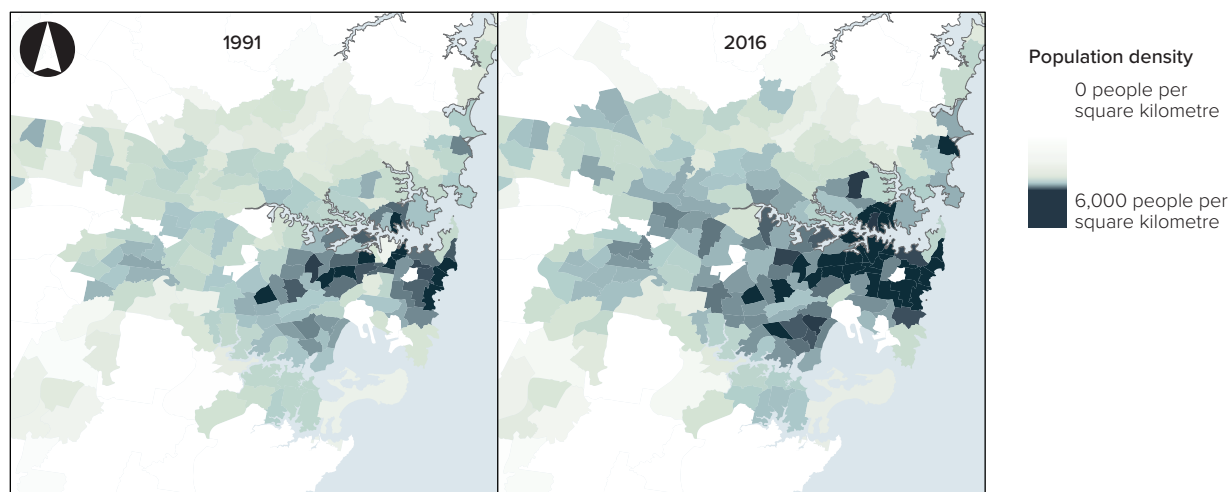
^a Population of the four largest Greater Capital City Statistical Areas (GCCSAs).

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

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

Source: Australian Bureau of Statistics (2019)¹⁶⁶

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



Source: Australian Bureau of Statistics (2017)¹⁶⁷

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

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

We are more diverse and living in different ways

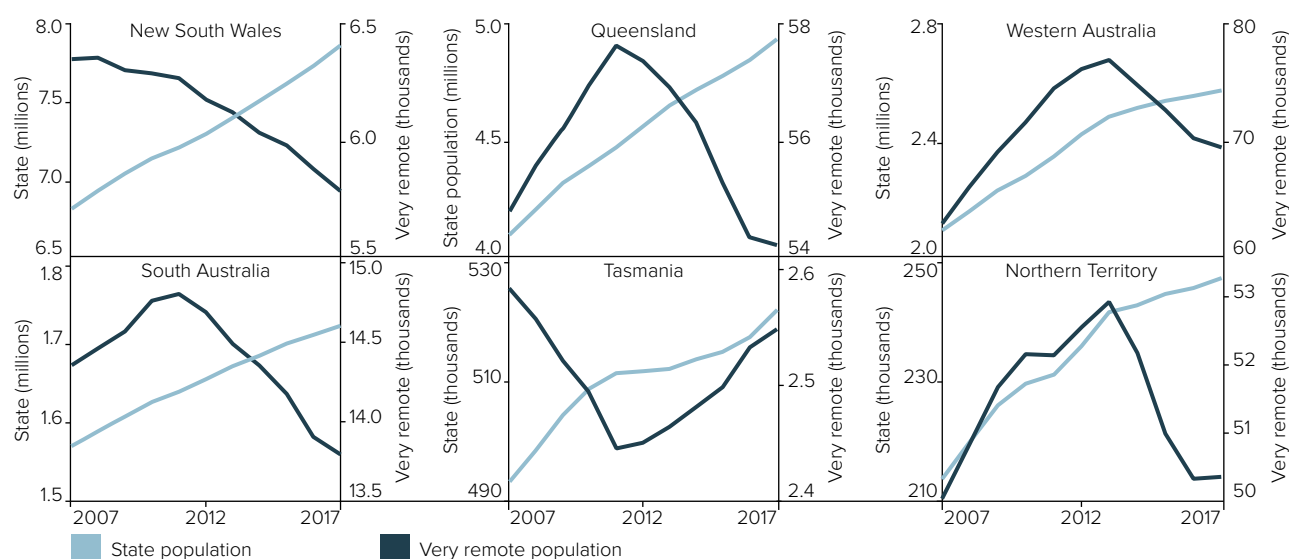
As Australia grows, so too will our cultural and linguistic diversity. Effectively half of Australia's population today was born overseas or has a parent who was born overseas. Moreover, we have the most diversified workforce by country of origin of any developed nation, save Switzerland. Cultural

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

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

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

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



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

Source: Australian Bureau of Statistics (2018)¹⁷⁵

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

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

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

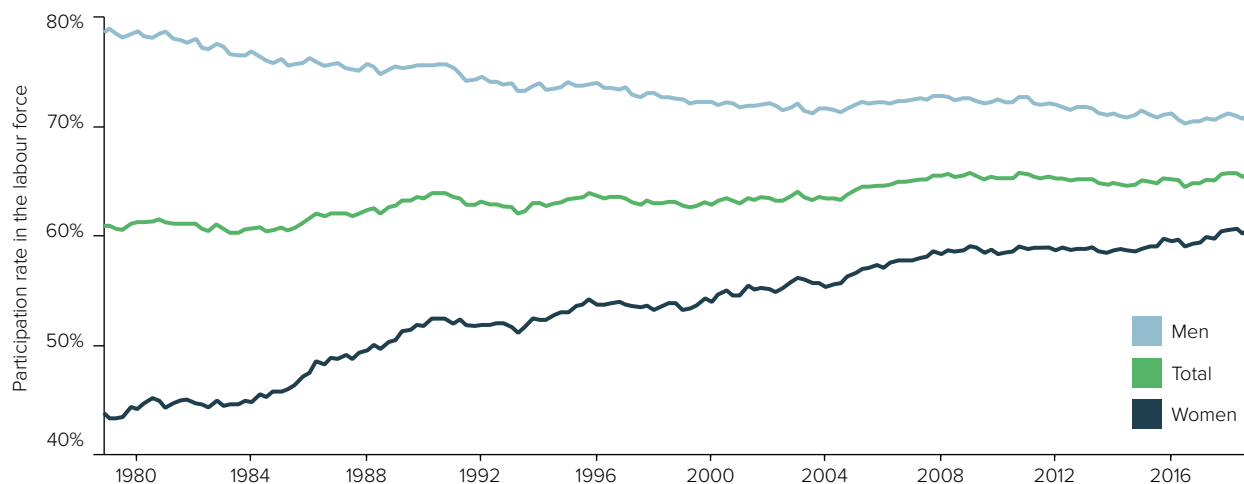
The digitisation of the economy and the emergence of sharing markets are creating new environments for workers, bringing both flexibility and uncertainty. The growth of the gig economy has implications for job security and cost of living pressures, as it relies on contracting to supply labour. Independent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

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

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

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

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



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

Source: Australian Bureau of Statistics (2019)¹⁸⁹



Our ageing population poses economic and social challenges

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

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

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

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

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

Technology and data – snapshot

Just over
90%

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



Q **3.9 million**

Google searches globally per minute (2018) ¹⁹⁶



Key technologies in the near term:

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

2.5 quintillion bytes

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

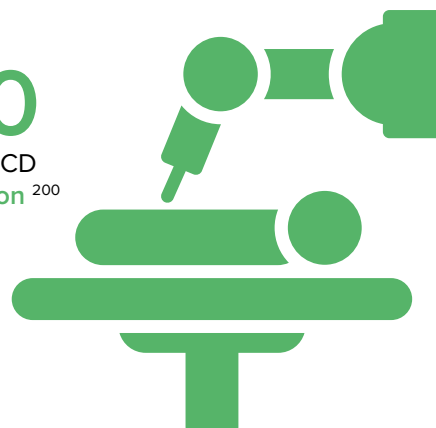
of data created per day ¹⁹⁸



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

1 in 10

jobs across the OECD
at risk of automation ²⁰⁰



2.7 Technology and data

At a glance

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

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

The section also looks at the challenges we face in:

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

Fast-changing technology is shaping our society

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

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

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

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

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

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

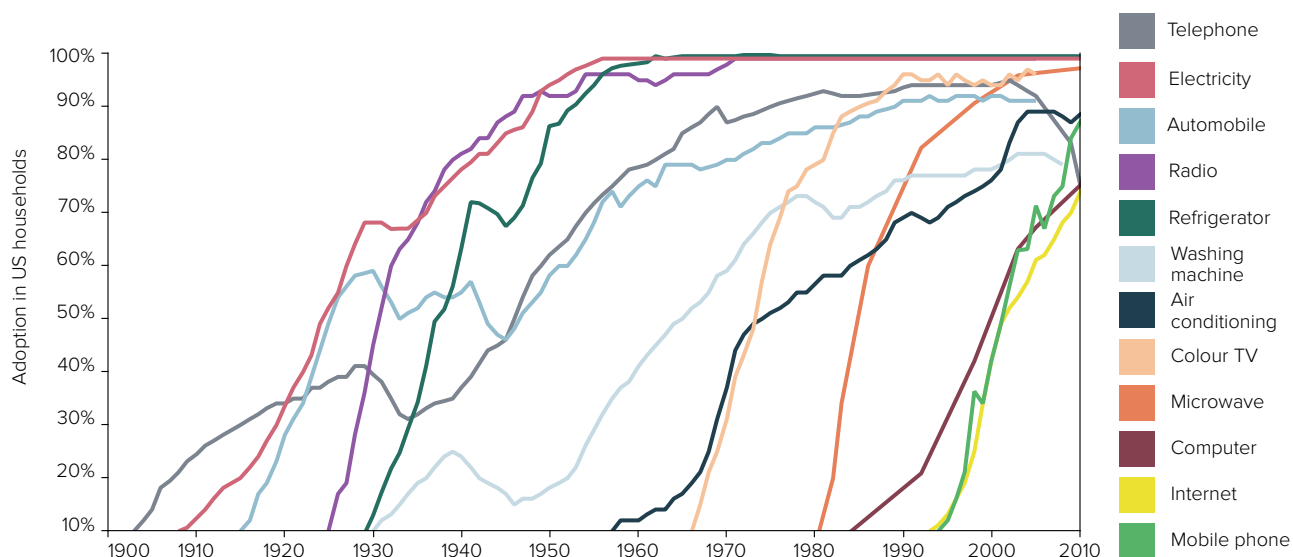
- **Media and public dialogue:** Across Australia, newspapers, TV and radio are increasingly produced in a few metropolitan areas and the investment in traditional newsgathering and programming has decreased as online media absorb the spending of advertisers.

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

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

Rates of technological uptake are accelerating

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

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

Source: Ritchie and Roser (2019)²⁰⁴

Uptake of new technology in Australia is varied

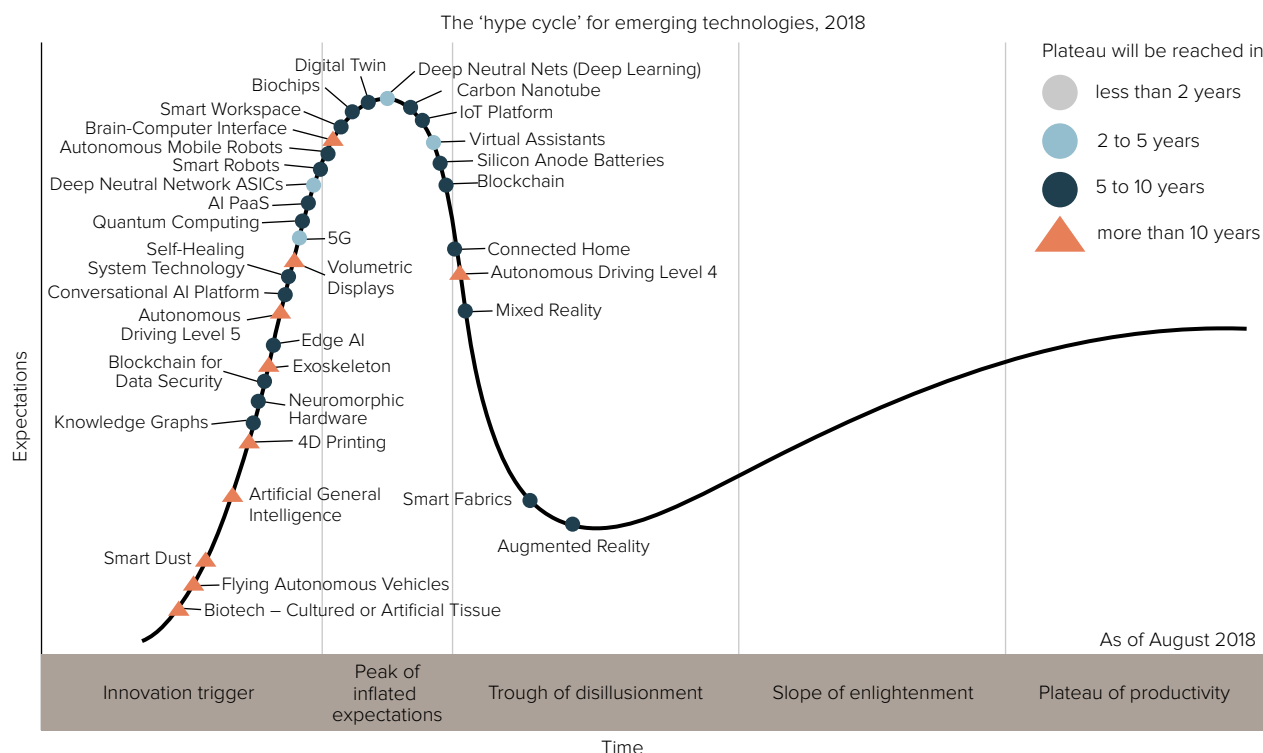
While the global rate of technological adoption has increased, Australians have not embraced all new technologies in the same way. Uptake has been relatively rapid and pervasive in Australia for:

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

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

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

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

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

Technological opportunities for Australia are varied

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

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

Australia's future technologies

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

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

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

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

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

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

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

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

technology to create improved experiences for players.

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

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

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

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

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

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

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

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

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

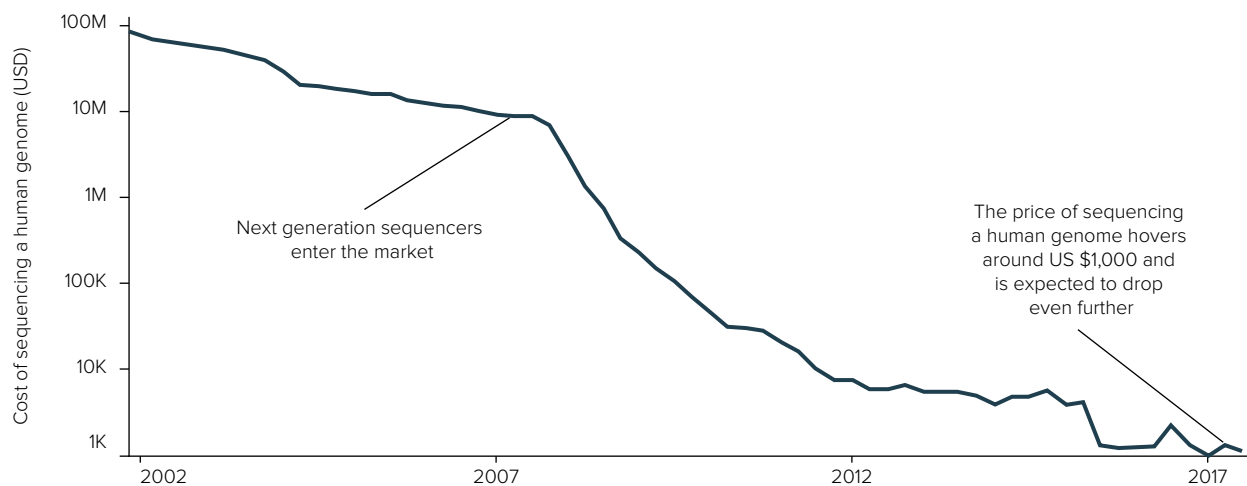
In addition to computer processors, other technologies have also become much cheaper and more powerful over time, including consumer products like household appliances and telecommunications equipment.²¹⁸ While current solar energy technology and battery cost reductions are not as steep as for integrated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

Australia struggles to leverage its technological expertise

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

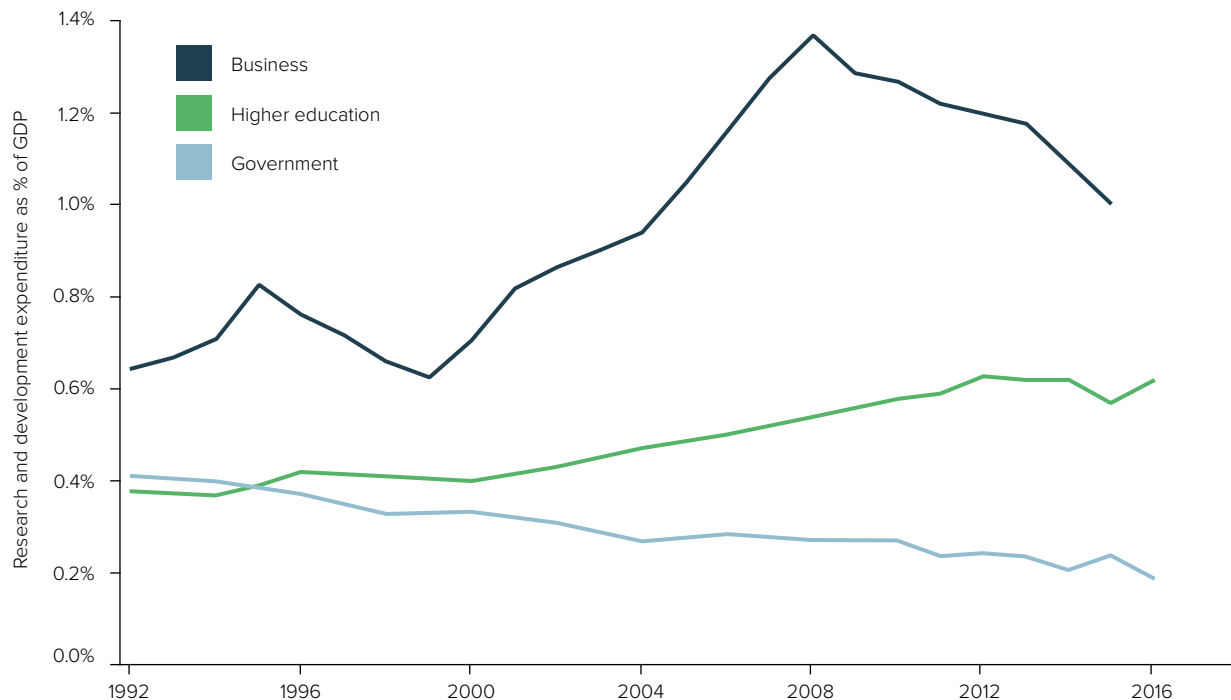
As Figure 28 shows, business spending on research and development (R&D) as a share of GDP peaked in 2008-09 and has fallen steadily to 73% of the pre-GFC height.²²² Direct government spending on R&D halved between 1992 and 2016, while higher education spending is growing modestly, yet not at a rate to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

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



Source: National Human Genome Research Institute (2017)²²³

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



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

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

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

New technology can require new forms of regulation and control

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

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

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

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

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

Providing equitable and affordable access to technology will be challenging

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Environment and resilience – snapshot

Birds in the world

70% chicken and poultry
30% wild



Land mass

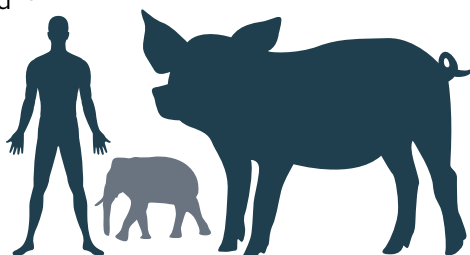


Population



Mammals in the world

60% livestock
36% humans
4% wild ²³¹



90% of Australians

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

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



Average rainfall in southeast Australia

declined by 11%
since 1990s ²³⁴

Australians produce
9% more waste per person
than comparable nations ²³⁶



2.8 Environment and resilience

At a glance

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

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

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

Our society and economy have been shaped by our environment

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

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

Our unique environment faces threats from human activities

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

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

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

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

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

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

Environmental challenges and responses vary across Australia

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

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

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

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

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

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

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

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



Climate variations will be exacerbated by climate change

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

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

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

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

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

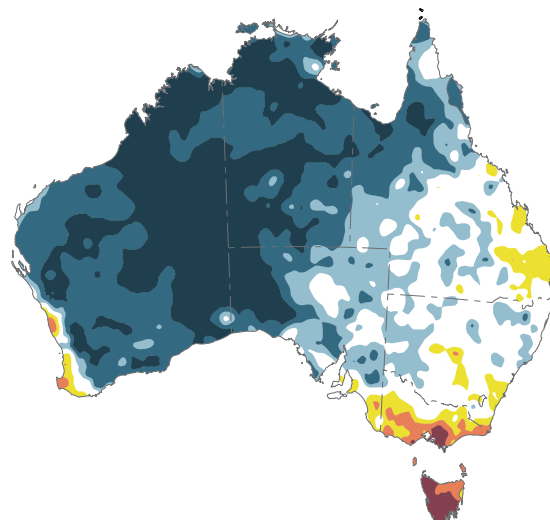
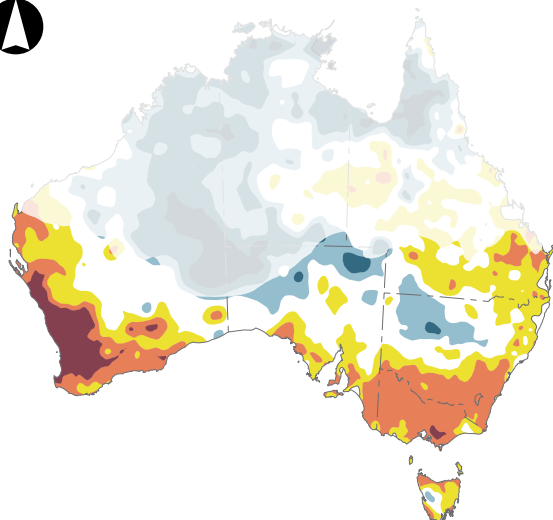
As a dry continent, rain is essential to maintaining liveability and productivity in Australia. Average rainfall in the south east of the country has declined 11% since the late 1990s, while it has increased across northern Australia, particularly during the wet season (October to April) (Figure 29).²⁶²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

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

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

April to October

October to April



Rainfall decile ranges

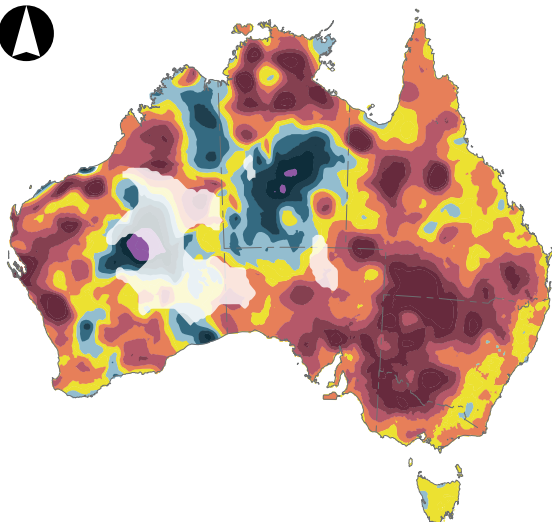


Note: Areas across northern and central Australia that receive less than 40% of their annual rainfall during April to October have been faded.

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

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

Change in forest fire danger index to 2018



Forest fire danger index points/decade



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

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

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

Australia is a high per capita emitter of greenhouse gas emissions

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

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

This is due to a number of reasons, including:

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

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

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

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

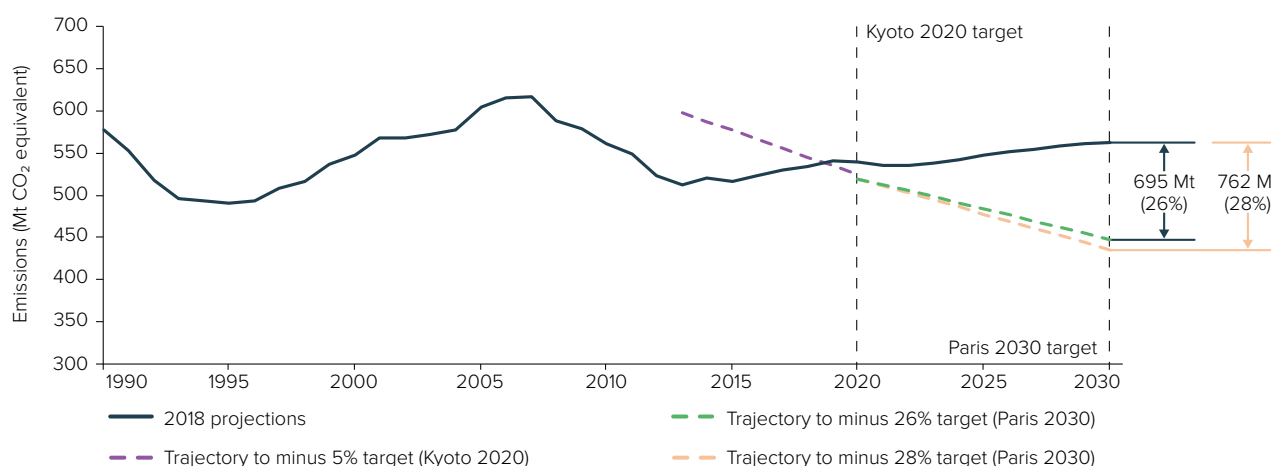
The Department of the Environment and Energy forecast in the Package that these measures, plus other technology improvements and abatement sources, energy performance improvements, Snowy 2.0, and Australia's level of reductions against its Kyoto Protocol targets, will position Australia to meet its Paris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

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

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

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

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



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

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

Environmental adaptation and resilience provide broad community benefits

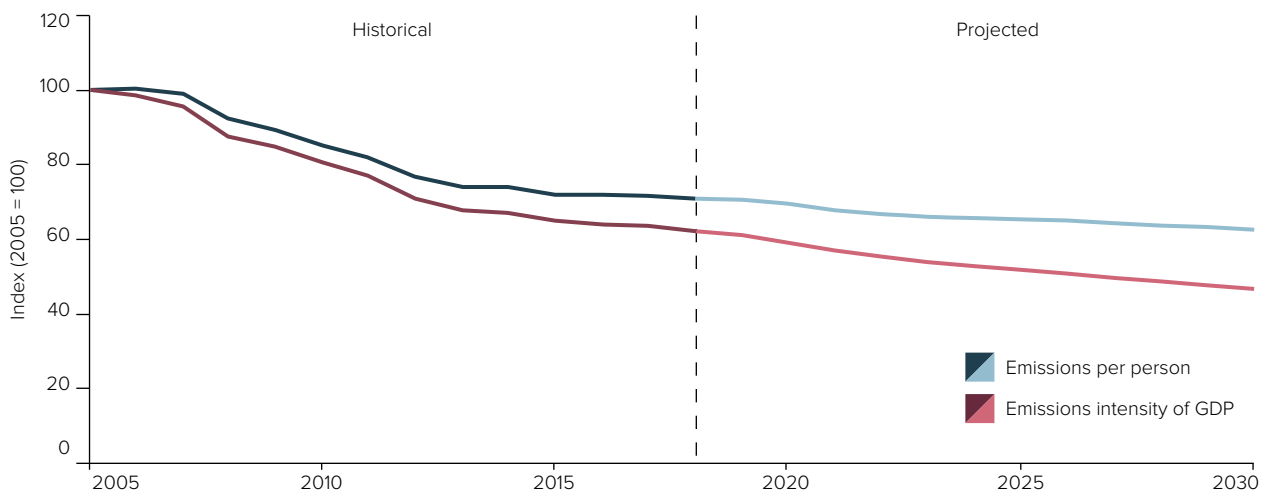
Responding to short- and long-term shifts in our environment is driving adaptation in the way we interact with our infrastructure and built environment, and the land, ocean, air and biodiversity. Adaptation to a changing environment is an ongoing process for a country as large and diverse as Australia.

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

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

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

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



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



Building resilience through our cities and infrastructure

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

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

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

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

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

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

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3

Infrastructure services for users

Across all sectors, users share expectations of easy access, high quality and low cost. We expect infrastructure to be available when we need it, and for it to be provided efficiently, securely and sustainably. To help Australia grow and prosper over the coming years, our infrastructure will need to ensure our vital needs are met, while offering greater personalisation of services to unlock our full potential as a nation and compete in increasingly connected and competitive global markets.

This chapter outlines Australians' end-to-end infrastructure needs according to where they live, and summarises the key trends influencing the nationally significant networks, assets and services on which we all rely.







3.1 Introduction



Infrastructure is meeting many users' needs, however will need to continue to evolve to meet future needs

In most parts of the country, users' needs are being met relatively well. Most Australians are broadly positive about services in their area, with most people we surveyed reporting that the infrastructure they use is largely good quality and easy to access. Across most services, particularly mobile and broadband services, Australians expect quality to improve over the next five years.¹

But our infrastructure can do better:

- Across all parts of Australia, users feel infrastructure is adding to cost of living pressures. Many users identified energy affordability as a particular concern,² but other sectors also place a significant impost on users. The average household spends over \$300 each week on infrastructure – or \$16,000 annually.³ These costs comprise almost a third of total disposable income for lower-income earners.⁴
- One of the most visible indicators of infrastructure quality, congestion, is growing. These costs in fast-growing cities detract from productivity benefits and reduce liveability. Road congestion and public transport overcrowding is estimated to cost the Australian economy \$19.0 billion in 2016, and without action, is expected to double by \$39.6 billion by 2031.⁵
- Poorer access to services in many outer-urban, regional and remote communities are reinforcing disadvantage, eroding confidence in the long-term viability of some communities, and concentrating economic opportunities in fewer parts of Australia.



Services have improved for many users, but outcomes vary

The size of our country and the diversity of our needs present challenges for ensuring all users receive infrastructure services that are accessible, affordable and good quality. This infrastructure underpins our success as a nation. Almost all Australians have safe, reliable running water and wastewater services in their homes.⁶ They are connected to electricity grids that meet 99.998% of expected customer demand.⁷ There is near-nationwide access to broadband internet, and we have one of the most extensive transport networks of any country. Most Australians have access to education,⁸ health,⁹ and other social services that compare favourably with most other countries.

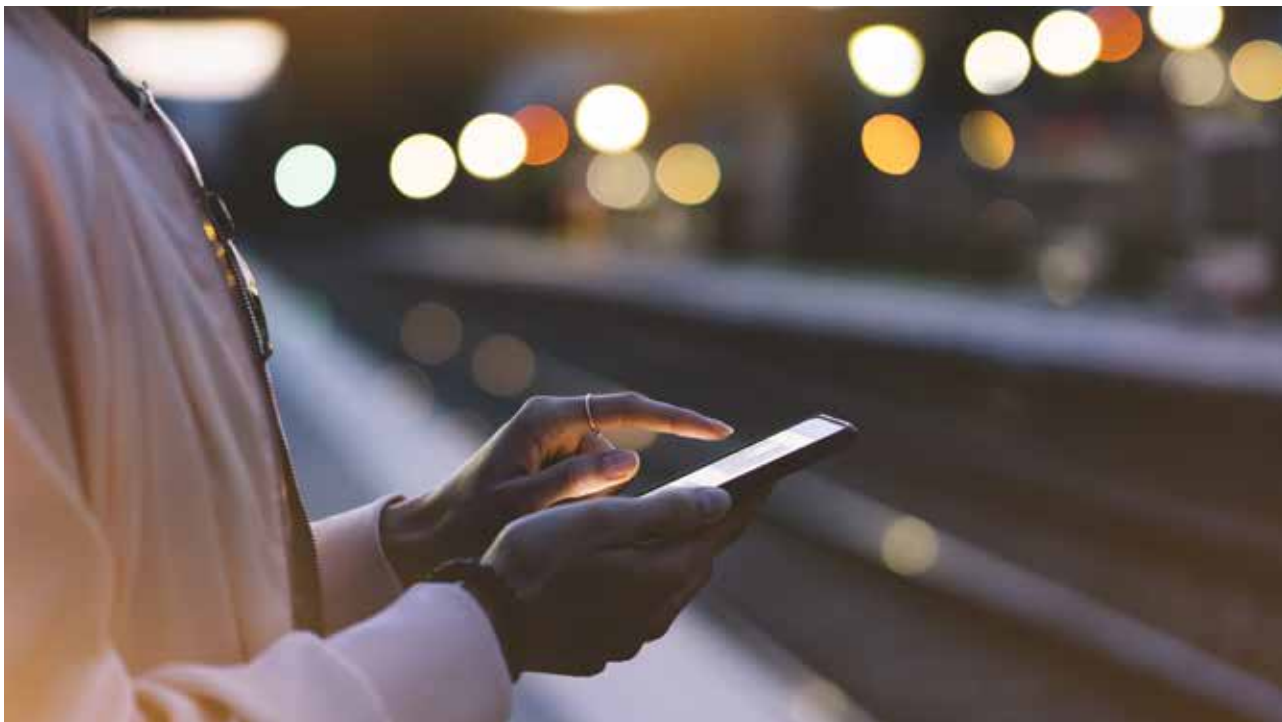
However, the outcomes our infrastructure provides for users have varied greatly. Users in our cities have typically have access to high-quality infrastructure at affordable costs. However, the pace of growth and change in our fast-growing cities have put many legacy networks under strain, leading to rising costs of congestion and crowding, and diminishing green space in many suburbs. Many governments are investing heavily in new infrastructure to meet demand. However, these changes pose a risk to the liveability and productivity of our cities if not adequately addressed.

Service quality in regional centres and remote communities has often lagged the cities, with limited access to services and little or no choice of supplier. Improvements in digital connectivity have helped, providing access to essential services and greater economic opportunities. However, many areas outside cities still suffer poorer service quality and reliability. Failure to address these service gaps could drive growing inequality and threaten the viability of some small towns and rural communities.

Since the last Audit, technologies and investments have brought some improvements

In the four years since the first *Australian Infrastructure Audit*, some infrastructure services have evolved considerably, driven by the availability of new technologies and large-scale investments by the public and private sectors.

Developments in technology have put users at the centre of infrastructure markets. For example, ridesharing and carsharing have provided new travel options for our cities. Household solar and storage technologies have enabled millions of Australian households to produce their own energy, export it to the grid, and reduce their bills.



Increasingly rich information that informs infrastructure use is now at users' fingertips. Real-time data on congestion, transport timetables and public transport vehicle capacity, as well as energy usage and a range of health and education services, are being delivered online, such as via smartphones. Operators are using this data to better meet the needs of users, and offer greater choice of services to more people.

However, other services have not improved, or face pressures. Energy prices have risen by over 50% in the past decade – and by much more for some users – putting increasing strain on household budgets.¹⁰ Congestion on our roads and crowding on public transport has worsened in many of our fast-growing cities. Some Australians still do not have access to high-speed internet, reliable mobile coverage or clean drinking water and sanitation. Within this patchwork, many Australians find it difficult or impossible to access the services they need. Those on the outskirts of our cities or in the regions typically experience a worse standard of transport services than those in inner-urban areas.¹¹ Almost half of Australians aged over 65 do not use the internet, limiting the range of services they can access.¹²

Our infrastructure needs are diverse but share common objectives

Users share common needs for infrastructure to be accessible, affordable and high-quality. But beyond these high-level outcomes, needs differ greatly between people, places and industries. Australians require infrastructure that responds to local and national needs.

While Australia has evolved as a federated country of eight states and territories, these boundaries bear little relevance for the different needs of people in each jurisdiction. Instead, the scale of each city, town and community provides a better guide for the needs of its users. Drawing together settlements of a similar size, there are often common user needs and roles for infrastructure, providing opportunities for benchmarking and sharing effective solutions.

But across many parts of the country, and most sectors, there is a lack of reliable and user-focused information. This makes tracking progress against these user-focused outcomes difficult. A lack of user-oriented evidence also means that decisions may fail to focus on the long-term interests of users, or may be based on evidence that does not accurately forecast future demand for services.

We need services to be more flexible, personal and support our broader aspirations – including improving sustainability and reducing emissions. Advances in technology are helping to facilitate these changes, but there is a growing role for governments to provide leadership on how and when these changes are integrated in infrastructure markets. Leadership is also required to set how changes in infrastructure markets help us to meet our broader vision for Australia, and the role we want infrastructure to play in that future.

In this chapter

This chapter sets out the broad national areas of focus for Australia's infrastructure. Its focus is on framing infrastructure services through the eyes of users, drawing out the trends and evidence from across the country. It touches on a number of topics that are explored in more detail in later chapters that focus on individual sectors, and identifies challenges and opportunities that require a national response.

3.2 Infrastructure that works for users is a key theme that is echoed throughout the Audit, particularly through references to the primary user outcomes of access, quality and cost. New forms of service delivery and technologies offer promise for improving user outcomes, and extending benefits to more Australians, but may not immediately be available for all users.

3.3 Costs and affordability highlights issues for households. Examining the total impact of infrastructure costs, this shows that the average Australian household's total infrastructure bill is rising, with costs hitting some of the most disadvantaged Australians hardest.

3.4 Infrastructure for fast-growing cities looks at services in Sydney, Melbourne, Brisbane and Perth that have provided Australia with immense opportunities, but may be struggling to keep pace with growing and changing needs, and how it may need to adapt over coming years.

3.5 Infrastructure for smaller cities and regional centres discusses that many of these places have room to grow and take some pressure off infrastructure in fast-growing cities, and act as service hubs for surrounding regions.

3.6 Infrastructure for small towns, rural communities and remote areas looks at the final geographic area, where services play a vital role in providing connections to economic and social opportunities. It notes that service quality does not meet an adequate standard for many of Australia's most remote regions.

3.7 Infrastructure to support regions and unlock growth in northern Australia takes a different perspective. This explains how the right infrastructure in the right place at the right time can catalyse growth and unlock opportunities, and help industries to overcome distinct challenges in regional areas.

Performance of the sector

Access

Australians are most optimistic about **access to mobile and broadband** services, with

35%

of people expecting improvements ¹³

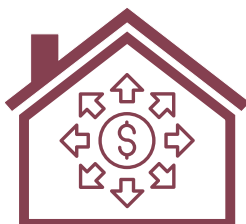


Cost

Australian households spent on average

\$314.39

on infrastructure per week ¹⁴



Quality

Australians are least positive about **the quality of social and public housing**, rated as **poorest of all sectors**, and least likely to improve ¹⁵



Quality

Without action, road and public transport congestion could double to nearly

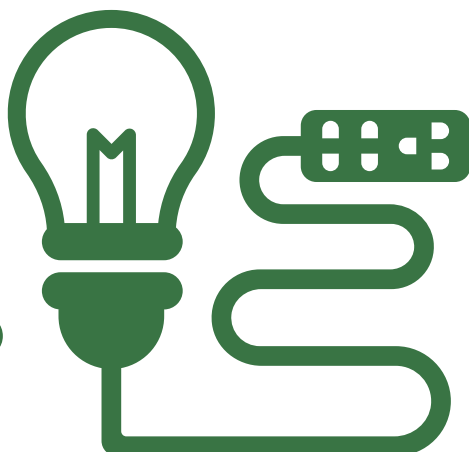
\$40 billion

by 2031 ¹⁷

Access

99%

of Australians are connected to electricity ¹⁶



Cost



Cost

Average Australian household's weekly infrastructure spend ¹⁸

	\$205
	\$45
	\$41
	\$23

Quality

7 in 10 Australians

are concerned about the level of **population growth** in their area ¹⁹



13.8% vs 16.8%

South Australians spend the least of their income on infrastructure costs, while **Victorians spend the most** ²⁰

Access

99.4%

of Australian premises have mobile coverage ²¹



Scale of the sector

Industry

Smart TVs


are the most commonly used smart household appliance, with **more than one third** of Australians using one in 2018 ²²

Customer

Better functioning cities and towns could deliver a **\$29 billion increase** in GDP in the long-term ²³

Asset

877,651 kilometres of roads in 2018 ²⁴



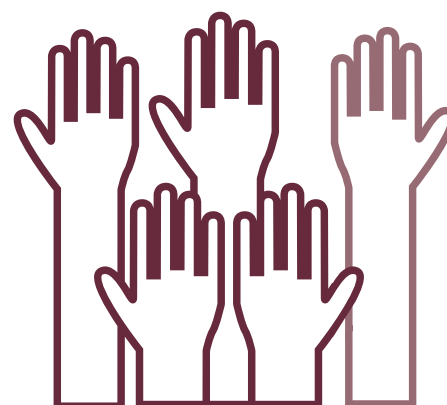
Asset



Roads are the most important infrastructure type in deciding where people live, with

8 in 10 people rating them as important ²⁵

Customer



4 in 5 Australians

believe it is extremely or very important to **consider the views of the community** when planning and investing in major infrastructure ²⁶

Customer



2,550,697 domestic, and



753,098 international flights over the past four years ²⁷

Industry

Annual electricity emissions have fallen

by 15 Mt CO₂-e since 2005, but this has been more than **cancelled out** by rises in transport (20 Mt CO₂-e) and fugitive emissions (16 Mt CO₂-e) ²⁸

Industry

Community opposition has contributed to the delay, cancellation or mothballing of more than

\$20 billion

of infrastructure projects in the last decade ²⁹



Asset

For **27% of people**, access to mobile and fixed communications is the **most important** infrastructure type when choosing to locate their business ³⁰



3.2 Infrastructure that works for users

At a glance

Infrastructure is only as good as the user outcomes and quality of service it delivers. This section explains how our infrastructure can focus on users by looking at their key priorities: access, quality and cost.

Service levels vary by location, and governments are working to distribute access more evenly. Technology can help, but may also worsen inequality as cities adopt changes faster than regions.

We also look at how:

- new technologies can offer more personalised service
- users can change their behaviour to make better use of our infrastructure
- the infrastructure sector can address barriers to digital access so changes do not leave some users behind.

Reporting on infrastructure does not always match users' needs

Infrastructure is not an end in itself. It is not so much an engine of growth as an enabler of growth.³¹ It exists to provide services to users in a way that best meets their immediate and future needs. Focusing on improving user outcomes helps to crystallise decisions to invest in infrastructure or reform the way it is governed and delivered.

Just as Australians' lives differ greatly across the country, so do our infrastructure needs. Meeting the needs of users varies greatly across the different parts of the country, both in terms of what users require, and what is equitable and efficient to provide. However, there are similarities between what users seek. These outcomes fall into three broad categories:

- **Access:** the availability of services for households and businesses, and how easy it is to use them
- **Quality:** the standard of the service provided, covering capacity, reliability, efficiency and customer experience
- **Cost:** the total cost impact on users, including upfront and ongoing charges for users, as well as the draw on taxpayer funds.

While much is changing across the country, we know that these outcomes will be just as important in 20 years' time as they are today, and as they were 20 years ago. That helps to provide clarity and focus when planning for the future.

However, public reporting on infrastructure, when it does occur, often does not reflect users' experiences and is rarely described in terms that are meaningful to individuals.³² This makes assessing the performance of assets, networks and services difficult, and limits opportunities for households, businesses and political representatives to make informed choices about the infrastructure we use.³³

A lack of adequate performance data also makes it difficult to track the impacts of infrastructure on the wellbeing of communities. This is an issue across all sectors, compromising our ability to prioritise investment for the long-term common good. Where reporting does occur, variations in definitions between jurisdictions limits the ability to draw meaningful comparisons. Responsibility in addressing this lies with the governments and regulators that oversee each form of service delivery.

1. Challenge

Governments and service providers do not always adequately measure and report on access, quality and costs for users. Insufficient user-focused data makes it difficult for users and policy makers to make decisions that improve user outcomes.

When this will impact:



Where this will impact:



In the past, location has defined service levels

Australia's population is highly urbanised and concentrated around coastal regions. In many ways, this pattern of settlement has defined how users' infrastructure needs have been met since early European settlement, and is likely to continue to define infrastructure networks' capacity to meet our future needs.

For the fast-growing cities of Sydney, Melbourne, Brisbane and Perth, meeting users' needs has become easier over time. Higher population densities have enabled efficiencies through scale in service delivery, and the creation of competitive markets for services across most sectors. Users in these cities have grown to expect high levels of access to services, while competition has driven improvements in quality and cost in many markets.

However, growth in these cities is leading to declining infrastructure outcomes in some areas – particularly in outer suburbs. Rising congestion and crowding on transport networks is eroding access for many users, and adding to the costs of doing business. Areas that are affected by this trend include Sydney's western suburbs, the north western suburbs of Melbourne and the coastal strip of Perth. Many hospitals and schools have reached capacity or are showing signs of age, requiring the construction of expensive new and upgraded facilities, especially in inner-urban areas. One example of this is the Queensland Children's Hospital, which received \$20 million from the Queensland Government to increase the number of beds.³⁴

In more remote parts of the country, access to services has historically been limited for many users. The challenges of service provision, such as vast distances between communities and a lack of scale, have driven up costs, while reliability and efficiency of remote networks have also been generally poor. In many parts of the country, service provision remains below equivalent services in more developed areas, and below what is acceptable for a highly developed nation that prides itself on a fair go for all.

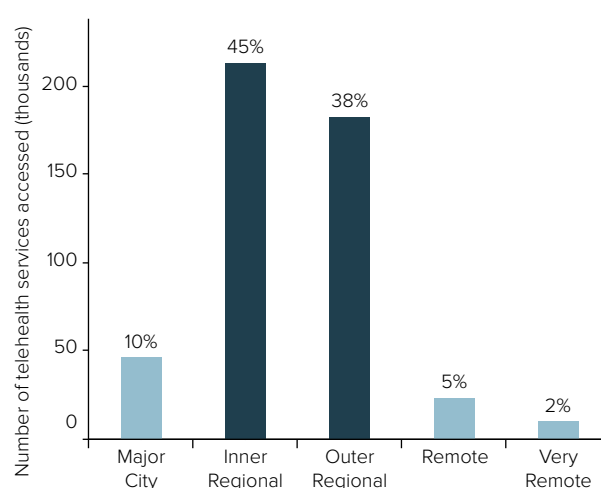
Technology can help to overcome the challenges of geography

In the past, infrastructure has typically been provided as a top-down, one-size-fits-all proposition. Service offerings were often inflexible, inefficient or unreliable, and operators seldom adapted their approach to better meet the needs of individual customers or groups of users. This service model has evolved, with operators becoming more responsive and increasingly prioritising outcomes that matter to users. The personalisation of infrastructure ownership, for example, installation of rooftop solar or access to ridesharing services, has allowed the pace of change to be dictated from outside established centralised regulators, market operators or asset owners. New technologies have partly enabled this trend, for example:

- Ridesharing services and on-demand public transport in some cities also offers users greater flexibility, choice and convenience, while extending the reach of legacy networks to poorly serviced areas.
- Real-time congestion data has helped motorists to avoid unnecessary delays, and helped businesses to reduce transport costs through improved efficiency.
- Household battery storage has helped users in small towns, rural communities and remote areas manage their energy bills, and offered these users more flexibility and choice about how they consume or export their electricity.³⁵

These developments have enabled some of the relative disadvantages for service provision outside of cities to be partially overcome. For example, telehealth has allowed some of Australia's most remote communities to receive specialist advice and treatment for almost half a million patients without needing to travel vast distances (Figure 1).³⁶

Figure 1: Telehealth has improved access to health care services for many regional users



Source: Department of Health (2016)³⁷



2. Opportunity

Technologies can help to overcome barriers to service access as a result of distance or location.

Better access to services through improved technology can bring economic and social opportunities for users outside of fast-growing city centres.

**When this
will impact:**



**Where this
will impact:**



New technologies can bring personalised services

Infrastructure users are increasingly being provided with a greater choice of services. This change is, in part, being made possible by new technologies, including smartphone applications, but also connected devices, individualised customer identifiers, smart tokens, smart meters, GPS trackers, and Internet of Things-enabled connectivity on household appliances.

This technology enables personalisation and targeting of service offerings, live updates of service times, service delays, cancellations, outages and capacity, as well as providing ways of redistributing and rebalancing supply and demand through third-party applications. New technologies can also improve personal safety and security of users by tracking their journeys, alerting others to their location, or contacting operators or authorities to raise alerts about problems with the service or emergencies.

Many applications generate and collect vast amounts of data on users, including their habits and preferences. Much of this data is used by operators to improve their services over time. However, increasingly technologies are developing to improve on and adjust service demand in real-time. For example:

- Sydney Trains uses customer smartphone data and third-party apps to show carriage capacity and to direct waiting customers to empty carriages.³⁸
- The Australian Renewable Energy Agency has funded demand response trials, where utilities notify users through smartphones or smart meters of an incentive to reduce energy use during peak periods – an approach that is already mandated in countries such as South Korea.³⁹
- Google Maps uses GPS-determined location data to track traffic conditions and road congestion in real time, generating live traffic maps for users

How this data is collected, monitored and used lack sufficient regulation and is hidden from users. Users also expect that their data will be kept secure and that their privacy will be safeguarded both from cybersecurity risks, and from unwanted and unauthorised use by third parties. The Australian Government's new Consumer Data Right gives Australians a right to direct their transaction, usage and product data to competitors and comparison services, if they choose to do so.⁴⁰ The Consumer Data Right will first be applied in banking, but could be extended to include infrastructure services.

With the convergence of an increasing number of connected and geo-located devices, infrastructure services consumer data is a large potential pool with significant uses.

Using Wi-Fi data to improve transport services in London

In late 2017, Transport for London undertook a four week pilot scheme which collected anonymised Wi-Fi data from Tube travellers. The trial logged more than 500 million Wi-Fi connection requests from around 5.6 million customer devices.⁴¹ Users were informed about details of the trial through publicity and advertising to address privacy concerns.

Tracking user movements across the network enabled analysis of customer behaviour and preferences under a range of scenarios. These insights are being used to enhance customers'

experiences through more focused decisions to manage service supply and demand.

Data on route choice and the effects of delay on user demand will assist Transport for London to optimise service allocation and frequency. Tracking how customers move around train stations can aid in understanding the effects of congestion and travel delays on users' travel experience. And Wi-Fi data can provide a more accurate picture of events on the ground compared to touch-in data from travel cards.⁴²

Changing user behaviour can improve infrastructure utilisation

Governments around the world are increasingly turning to behavioural economics and behavioural psychology as tools to support the better use of infrastructure and improvement of service delivery through relatively cheap and expedient operational charges. Behavioural insights techniques have the potential to add significant value to helping to maintain access to infrastructure services through managing demand.

Australian governments have embraced these tools. An initial arrangement between the New South Wales Government and the London-based Behavioural Insights Team led to the formation of the NSW Behavioural Insights Unit in 2012.⁴³

Other jurisdictions have followed, including the:

- Behavioural Economics Team of the Australian Government (BETA)⁴⁴
- Victoria's Behavioural Insight Unit.⁴⁵

In particular, travel behaviour change projects can have a big impact on congestion and crowding on public transport.⁴⁶ A survey conducted by Infrastructure Victoria found that one in four surveyed peak period drivers could change their time of travel, while one in three said they could change their mode of travel.⁴⁷ The Western Australian Government has, since 1997, run localised travel behaviour change programs. The Your Move program currently focuses on a different town or city each year.⁴⁸

3. Opportunity

User data and customer insights can enable innovation to better meet users' needs. Better understanding users' needs can help operators to improve user experience, attract more users and provide services more efficiently.

When this will impact:



Where this will impact:



Changing technology risks leaving some users behind

While increased use of technology in infrastructure brings immense benefits, not all users are alike, and some developments have not benefited all types of users, including children, older people, people with disability, or other disadvantaged customers. Also, not all technologies are available to all users.

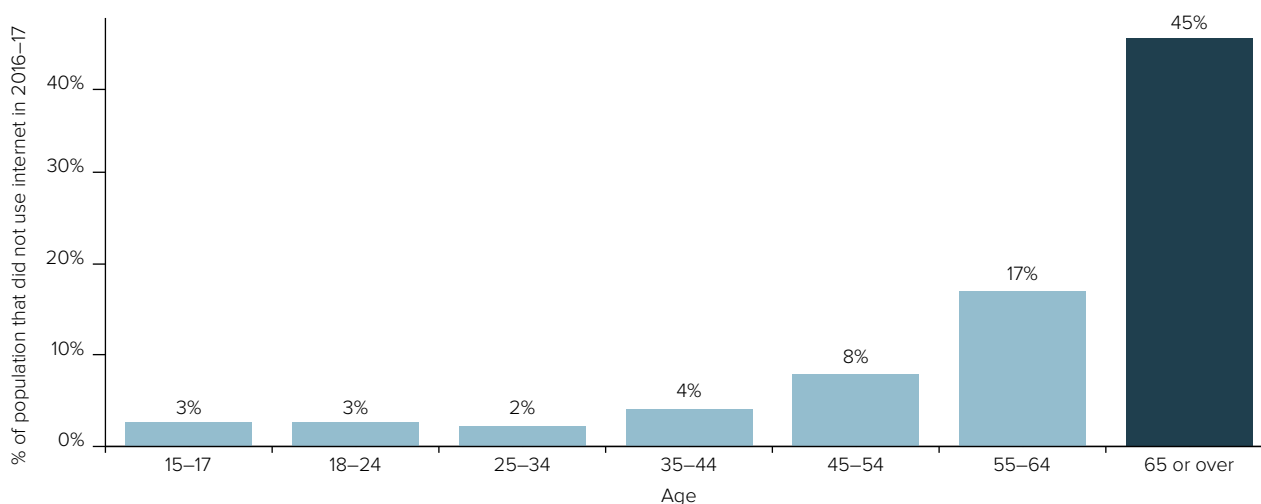
Changes in technology have delivered improvements to service effectiveness and efficiency. Contrary to some assumptions many changes have also reduced human interaction with service staff who can respond to individuals' needs. In some cases, a minimal level of technical competency is required to use new services.

Improvements in technology also increase barriers to entry, in terms of skill and knowledge, for those who have not accessed services in the past. Some users do not own a smartphone, or have insufficient digital literacy to access services such as ridesharing applications. Many infrastructure operators lack meaningful targets for improving access and quality for all users, or publicly available plans and strategies for achieving improvements. Digital inclusion can unlock improvements in outcomes for users at little or no cost, while connecting more users to online services can lower the costs of provision.⁴⁹

Advances in telecommunications are not reaching all Australians. Internet usage is lowest among older and lower-income Australians (Figure 2). However, there is also evidence that it is these groups who stand to benefit most from affordable access to the internet. Older Australians, who are connected, are more likely to use the internet for educational purposes. For example, 79% of NBN users over the age of 65 are engaged in non-formal education, compared with 52% of non-NBN connected older Australians.⁵⁰



Figure 2: Older generations are more likely to be disconnected from the Internet



Source: Australian Bureau of Statistics (2018)⁵¹

4. Challenge

Users that are disadvantaged, such as those with low digital literacy or people living with disability, may be unable to access infrastructure services provided through new technologies. Not extending the benefits of change to all Australians is likely to increase inequality and reduces quality of life by limiting access to services for some members of the community.

When this will impact:



Where this will impact:



3.3 Costs and affordability

At a glance

The affordability of infrastructure services is one of three key user metrics, alongside quality and access, that Infrastructure Australia has used within the Audit. We have considered how costs and affordability vary across our cities and regions, how vulnerable groups are impacted, as well as changes over time, and user perception of those changes.

The Audit has identified that:

- Average Australian household total infrastructure costs have risen in real terms
- However, on average, infrastructure costs decreased as a proportion of household incomes
- There is a lack of current and accurate data available to piece together the impacts of infrastructure costs on households
- Community perceptions on the scale of infrastructure cost rises do not always align with what they are actually paying
- Infrastructure costs are regressive and hit lowest-income households hardest.

Australian's total direct infrastructure cost have been rising in real terms

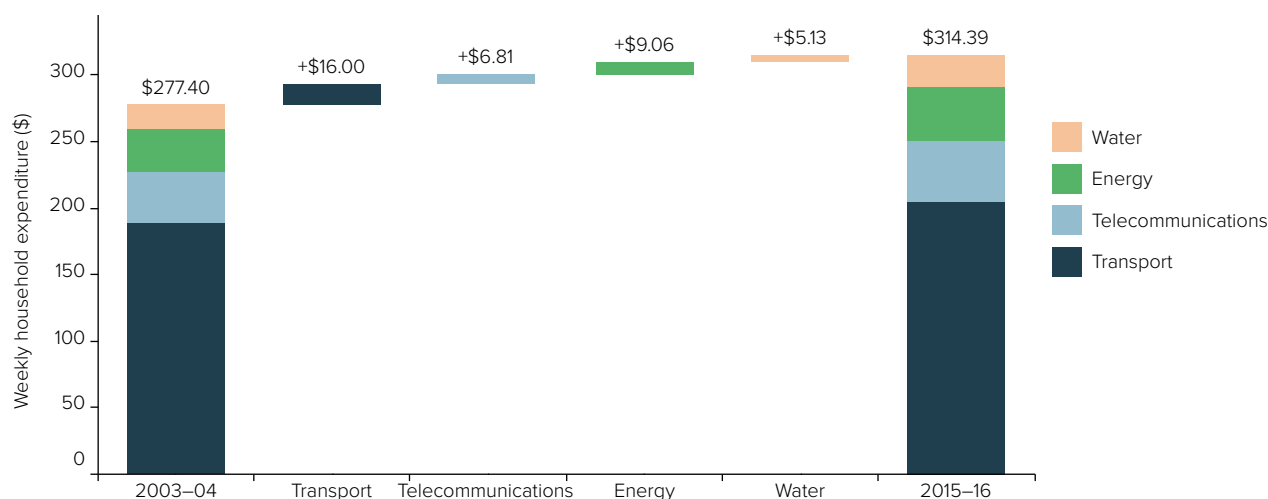
Infrastructure affordability is a concern for Australians across all sectors. This is why we have worked with the University of NSW City Futures Research Centre, and Astrolabe Group, to present a total infrastructure bill for an average Australian household. This analysis focuses on costs for transport, telecommunications, energy and water, but does not include social infrastructure costs.

Cost increases for infrastructure and related services are generally presented as individual items. However, due to the potential to substitute some infrastructure services, such as gas for electricity, or telecommunications for transport, what matters most is the total financial impact of these costs, combined with access to and quality of the services.

In 2015-16, Australian households spent on average \$314.39 on infrastructure costs per week (Figure 3). This comprises 15.6% of average disposable income and 21.9% of average total household expenditure. Household total infrastructure costs have increased 13% in real terms from 2003-04, when they were \$277.40 per week. However, infrastructure costs as a proportion of household expenditure have fallen slightly, from 22.9% in 2003-04 to 21.9% in 2015-16.

The fastest increase in costs are seen in the energy and water sectors (Table 1). Transport costs have risen slowest, but they comprise by far the largest portion of total infrastructure costs. This is primarily due to vehicle-related costs (such as purchases, registration, insurance, and servicing). Vehicle fuel, petroleum and diesel also comprise a major component of the cost.

Figure 3: Household infrastructure costs have increased



Note: Values are inflation adjusted to June 2016.

Source: University of NSW City Futures Research Centre and Astrolabe Group (2019)⁵²

Table 1: While weekly household infrastructure costs have risen the fastest for water and energy, transport still accounts for the largest share

Sector	2003–04	Proportion of total	2009–10	Proportion of total	2015–16	Proportion of total	Change (2003–04 to 2015–16)
Transport	\$189.11	68%	\$216.27	70%	\$205.11	65%	+8.5%
Telecommunications	\$38.50	14%	\$38.21	12%	\$45.31	14%	+17.7%
Energy	\$31.48	11%	\$36.46	12%	\$40.53	13%	+28.8%
Water	\$18.31	7%	\$19.01	6%	\$23.44	7%	+28.0%
Total costs	\$277.40		\$309.95		\$314.39		+13.3%

Note: Values are average weekly household expenditure, inflation adjusted to June 2016.

Source: University of NSW City Futures Research Centre and Astrolabe Group (2019)⁵³

5. Challenge

Limited reliable data exists to allow government, regulators and users to understand the total costs of infrastructure. Poor data limits the ability for government to understand the affordability of infrastructure services and cost of living pressures.

When this will impact:



Where this will impact:



Households in the Northern Territory and the Australian Capital Territory bear the largest infrastructure costs

Across Australia, households in the Northern Territory and the Australian Capital Territory pay the largest infrastructure costs (Table 2). In the Northern Territory, this is driven by higher water and sewerage costs, which are between \$8 and \$17 per week more expensive than other states and the ACT. Northern Territorians also pay the greatest costs for energy and telecommunications. Meanwhile, households in the Australian Capital Territory pay the highest transport costs and the second highest energy costs.

South Australian, Tasmanian and Western Australia households have the lowest costs. This is driven by lower fuel and vehicle-related costs compared to other states. South Australians and Tasmanians also have the lowest telecommunications costs.

When taking into account either household income or total household expenditure, Victorian households have the greatest burden (16.8% of disposable income, 23.1% of total household expenditure). South Australia and Western Australia have the lowest burdens of infrastructure costs when viewing through both these measures.

Table 2: Households in the Northern Territory and Australian Capital Territory have the largest average infrastructure costs, but Victorian households pay the highest proportion of income

State	Transport	Energy	Water	Telecommuni- cations	Total costs	Total as % of household expenditure	Total as % of disposable income
NSW	\$215	\$39	\$24	\$46	\$324	21.2%	14.9%
Vic	\$218	\$46	\$21	\$47	\$331	23.1%	16.8%
Qld	\$205	\$35	\$28	\$46	\$314	22.8%	16.5%
WA	\$180	\$40	\$30	\$44	\$293	20.4%	14.0%
SA	\$160	\$44	\$27	\$39	\$270	20.1%	13.8%
Tas	\$177	\$43	\$21	\$38	\$279	22.3%	16.5%
NT	\$217	\$49	\$38	\$53	\$357	20.7%	16.5%
ACT	\$222	\$47	\$23	\$46	\$338	20.3%	15.0%
Aus	\$205	\$41	\$23	\$45	\$314	21.9%	15.6%

Note: Values are average weekly household expenditure in 2015-16, inflation adjusted to June 2016.

Source: University of NSW City Futures Research Centre and Astrolabe Group (2019)⁵⁴

Calculating the cost of infrastructure to households is complex

The total household infrastructure bill has been constructed using data from the Australian Bureau of Statistics Household Expenditure Survey (HES) and from the Bureau of Meteorology National Performance Report. There are few other publicly available data sources available to infer meaningful trends on how infrastructure costs have changed over time.

The available public data have several known limitations. Firstly, the latest HES was performed in 2015-16, so it does not capture very recent price increases. Secondly, aside from transport, which has a wealth of subcategories, the other sectors have

limited detail within the HES in terms of types of costs, especially water. The Bureau of Meteorology National Performance Report's 'Typical residential bill' was used instead for water costs as it is derived from actual water bills. Thirdly, due to how data have been collected historically, it is not possible to compare how infrastructure costs have changed over time for all states individually.

The Household, Income and Labour Dynamics in Australia (HILDA) longitudinal survey is a well-known data source of household income and expenditure. While it is an annual survey and has considerable detail in its metrics on income and household factors, its expenditure data is less robust due to its simple methodology.

6. Opportunity

Improved collection of data, including by third parties (such as financial institutions) could support improved decision making using big data. Partnering with data owners to support the collection of detailed, up-to-date data, will allow better decision making. However, data privacy will need to be managed.

**When this
will impact:**



**Where this
will impact:**



Government infrastructure expenditure is also a cost to households

In addition to direct costs, Australian households also indirectly fund infrastructure provision through taxation and non-infrastructure charges. These charges facilitate part of general government expenditure. All levels of government levy taxes and charges in order to meet infrastructure costs.

The costs recovered by government through tax and charge revenue vary depending on where people live, their household composition, nature of tenure, levels of expenditure, and a range of other factors.

The variations across locations are often opaque, with the majority of revenue derived by jurisdictions not hypothecated to specific uses. However, in other circumstances, considered steps have been taken to ensure the use of indirect revenue for infrastructure purposes is more transparent. One such example is the Gold Coast City Council, which applies a series of infrastructure specific levies:

- Transport Levy – which has been used to fund Council contributions to the Gold Coast Light Rail (G:link), and other transport projects
- Open Space Levy – for the maintenance and preservation of natural public spaces
- Recreational Space Charge – for the acquisition of open space for recreational purposes

- Waste Management Levy – for the collection, processing and disposal of solid waste, including recyclables.⁵⁵

Some state and local jurisdictions levy specific on-off fees and charges on third parties, which are ultimately used to fund infrastructure. These fees and charges are eventually passed through to consumers in the form of increased costs of final products. One of the most significant uses of these charges is developer contribution. These levies apply to the property industry for infrastructure costs associated with delivering new or increased density development. These fees and charges ultimately form part of the upfront costs of property purchases.

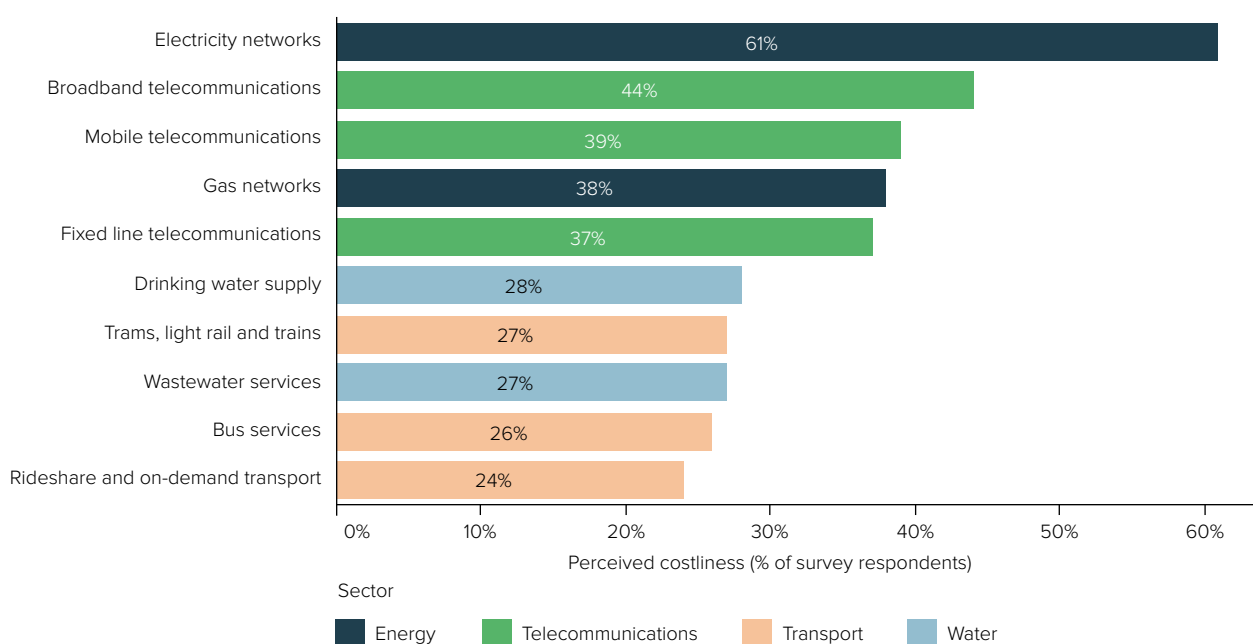
While these one-off charges create impediments to understanding infrastructure costs, the structure of whole-of-life charges can also be opaque. For instance, unlike other utilities such as electricity, property owners meet the direct water and rates (local infrastructure provision) costs of their tenants. Charges are then passed on through increased rent costs.

These myriad of charges applied through general taxes and through third-party charges obscure the true cost of infrastructure provision to users.

Community perceptions of infrastructure costs and usage patterns do not align with actual expenditure

Of all infrastructure sectors, transport is perceived as being the most affordable (Figure 4), which is in contrast to it being by far the most expensive.

Figure 4: Energy is perceived as the most costly infrastructure sector, while transport is perceived as the most affordable



Note: Values are share of survey respondents who answered 'costly' or 'very costly'.

Source: JWS Research (2018)⁵⁶

This may be influenced by transport spending being somewhat discretionary, in so far as it relates to vehicle purchase decisions, which is a large driver of the cost of transport spending. Australians have access to a wide range of vehicles, and subsequently discretionary consumer preference plays a large role in the selection of cars. For some Australians, cars are seen as practical tools, while for others, they are partially seen as a status symbol, so the decision to purchase an expensive car is therefore potentially driven by factors other than necessity.

This is less likely for other infrastructure sectors, however consumer preferences are an increasingly emerging trend in influencing other infrastructure-purchasing decisions. This will add further complexity to assessing consumer costs. For instance, many households with connections to water mains are opting to use water tanks. Additionally, electricity consumers are complementing the established centralised electricity grid with small-scale solar, and considering battery technology. Spending on the telecommunications sector is also influenced by mobile phone handset choice and by the types of services consumed using these devices, such as streamed entertainment content, which would historically have been provided using other media.

The proportional reduction of disposable incomes spent on transport between 2009-10 and 2015-16 could reflect changes in consumer preference for discretionary income on transport as a result of broader constraint on household budgets. This is potentially supported by the approximately 20% decrease in vehicle purchase costs from 2003-04 to 2015-16.

Conversely, most Australians feel that transport costs have not changed much in the past five years, and are not likely to change much in the next five years. However, transport costs have risen 8.5% in real terms from 2003-04 to 2015-16, and the nature of this increase differs by type. For instance, as shown in Table 3, falls in vehicle purchase costs have been offset by increases in motor fuel, registration and insurance, and other vehicle charges (including tolls, parking and fines).

Despite Australians consuming less electricity (8% per capita decrease from 2003-04 to 2015-16), and increasingly using solar electricity (6.3% of total electricity usage in 2015-16), they are paying more for household electricity.⁵⁷ This is most notable in Queensland, which has seen the greatest reduction in energy usage, and the greatest increase in energy bills.⁵⁸ Victorians, who pay the highest combined energy prices, use the most energy per capita. This is despite Victoria having the greatest reduction in per capita electricity usage (21% reduction per capita over 2003-04 to 2015-16).⁵⁹

These rising prices have resulted in most Australians perceiving that electricity has become less affordable in the five years leading to 2018.⁶⁰ In contrast, gas is perceived as not having changed in affordability, despite gas prices rising faster on a percentage basis than electricity. Gas comprises a smaller component of residential electricity bills, and is not used by all households, making it less visible for most consumers. This contrast is repeated in perceptions about the future, with most Australians expecting electricity to become less affordable, while almost half of those surveyed expect gas costs to remain the same as today.⁶¹

Table 3: Falls in vehicle purchase costs have been offset by increases in other transport-related costs

	2003-04	2009-10	2015-16	Change
Public transport fares	\$5.27	\$5.58	\$5.85	11.1%
Total vehicle purchase costs	\$73.93	\$62.05	\$59.26	-19.8%
Motor vehicle fuel, lubricants and additives	\$44.24	\$57.64	\$49.60	12.1%
Vehicle registration and insurance	\$32.03	\$32.39	\$35.55	11.0%
Vehicle parts, servicing and crash repairs	\$28.17	\$30.31	\$27.72	-1.6%
Other vehicle charges	\$5.48	\$28.29	\$27.13	395.0%
Total transport costs	\$189.11	\$216.27	\$205.11	8.5%

Note: Values are average weekly household expenditure, inflation adjusted to June 2016.

Source: University of NSW City Futures Research Centre and Astrolabe Group (2019)⁶²

Direct infrastructure charges are preferred, however they are regressive

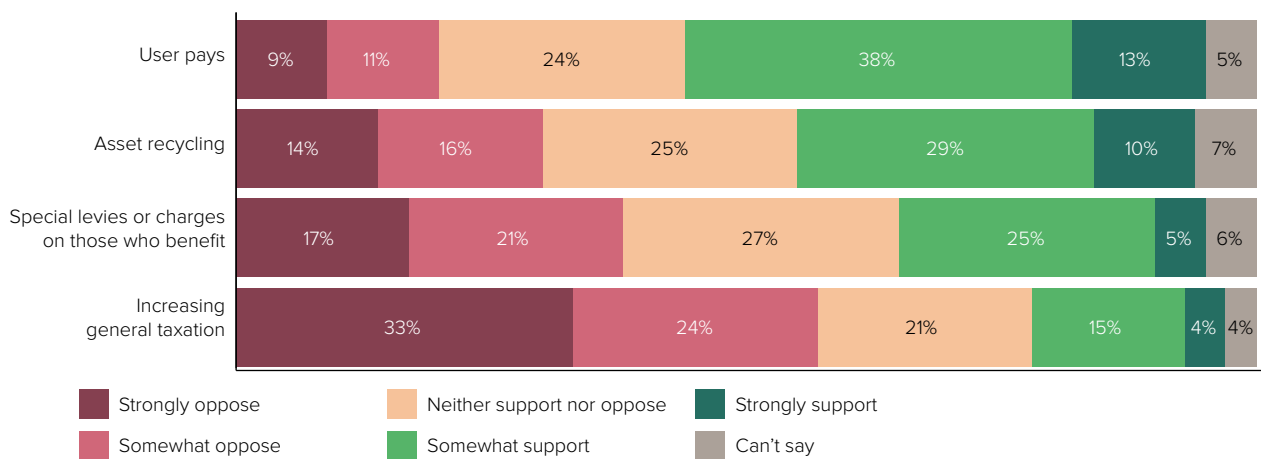
Research undertaken for the Audit showed that a majority of Australians support user pays as their preferred means for funding infrastructure investment (51%, Figure 5). This level of support is higher than for asset recycling, special levies and charges, and increases on taxation. Only one in five people oppose the application of user pays, while 57% oppose increases in taxation to fund infrastructure.

To analyse the way that infrastructure spending affects households of different incomes in Australia, households are ranked from lowest to highest income, and then divided to five equal groups with

20% of all households in each group (quintiles). The highest-earning 20% is referred to as the highest quintile, while the lowest-earning 20% is the lowest quintile.

While infrastructure costs are lower for households with lower incomes, they are a greater proportional costs to household budgets compared to higher-income households. On dollar terms, households in the highest income quintile spend over three times as much as those in the lowest quintile (\$551.19 and \$147.29 respectively, Table 4). However, households in the lowest quintile spend 32.0% of their disposable income on infrastructure, which is over twice as much as those in the highest quintile (14.8%, Table 5).

Figure 5: User-pays funding is the most supported means for funding infrastructure development



Source: JWS Research (2018)⁶³

Table 4: Households in the highest income quintile spend over three times as much on infrastructure costs than households in the lowest income quintile

Income quintile	2003-04	2009-10	2015-16	Change (2003-04 to 2015-16)
Lowest 20%	\$136.83	\$143.03	\$147.29	8%
Second 20%	\$195.46	\$205.58	\$209.35	7%
Third 20%	\$275.13	\$284.45	\$290.33	6%
Fourth 20%	\$347.39	\$361.22	\$373.74	8%
Highest 20%	\$431.69	\$555.32	\$551.19	28%

Note: Values are average weekly household expenditure, inflation adjusted to June 2016.

Source: University of NSW City Futures Research Centre and Astrolabe Group (2019)⁶⁴

Over time, the size of this disparity has decreased. In 2003-04, households in the lowest income quintile spent 38.9% of household income on infrastructure, which has fallen by 6.9%. For incomes in the highest income quintile, the reduction over 2003-04 to 2015-16 was only 2.2%.

The pattern of infrastructure bill stress for lower income households is repeated when viewing across individual infrastructure sectors. Households in the lowest income quintiles pay above affordability thresholds for all infrastructure costs, and pay considerably more than households in any other quintile for both water and energy costs (Figure 6).

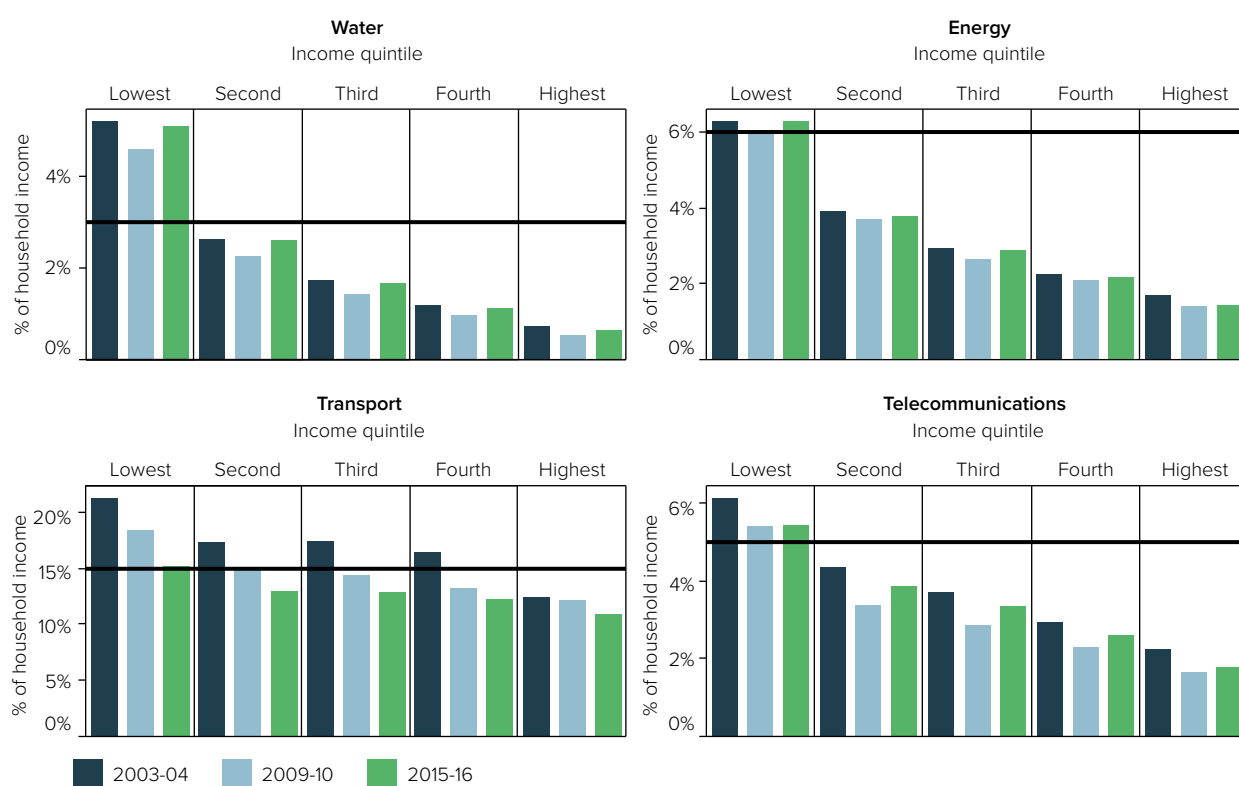
Table 5: Households in the lowest income quintile spend far more of their income on infrastructure costs than households in the highest income quintile

Income quintile	2003-04	2009-10	2015-16	Change (2003-04 to 2015-16)
Lowest 20%	38.9%	34.4%	32.0%	-6.9%
Second 20%	28.2%	24.3%	23.3%	-5.0%
Third 20%	25.9%	21.3%	20.8%	-5.1%
Fourth 20%	22.9%	18.6%	18.3%	-4.6%
Highest 20%	17.0%	15.7%	14.8%	-2.2%

Note: Values are share of household disposable income spent on infrastructure costs.

Source: University of NSW City Futures Research Centre and Astrolabe Group (2019)⁶⁵

Figure 6: Costs across all infrastructure sectors are on or above affordability thresholds for households in the lowest income quintile



Note: Values are share of household disposable income spent on infrastructure costs. The black lines show affordability thresholds for each infrastructure sector, which are informed by international literature.

Source: University of NSW City Futures Research Centre and Astrolabe Group (2019)⁶⁶



7. Challenge

User-pays funding for infrastructure has widespread support within the community. However, its regressive nature disproportionately affects low-income earners. Transport, energy, water and telecommunications infrastructure user costs are above affordability thresholds for our lowest income earners thereby reducing access to services and quality of life.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



A lack of simple information complicates choice for consumers

Transparency of information across infrastructure sectors is not uniform, and the Australian Competition and Consumer Commission has identified complex bills and discounting structures as barriers to user certainty.⁶⁷ As a result, levels of consumer engagement with and understanding of infrastructure costs vary substantially. Some consumers actively seek better offers and routinely change service providers, while others are content with their existing services and do not change for many years.

In 2017, the Australian Energy Market Commission found that 37% of residential consumers had neither investigated their energy options in the previous 12 months nor switched energy company or plan within the previous 5 years.⁶⁸ Lack of confidence in their ability to find the right plan was cited as a major driver.

Despite user-pays infrastructure, including toll roads, receiving the highest level of support amongst consumers⁶⁹, sentiment in some sections of the community regarding toll roads remains negative. This is driven, at least in part, by limited understanding amongst the community as to how tolls are calculated and by whom.^{70,71}

Users need to be informed to manage their costs, so it is critical they receive transparent and accurate information, particularly through their bills but also ahead of signing on to long-term plans or commitments.

Improvements in metering, such as smart metering for electricity and water, as well as electronic ticketing for public transport, allow infrastructure users to make more informed choices.

Consumers have growing means to take control of their bills, but some risk being left behind

For users to gain more control of their bills, not only will there need to be improvements in the way in which costs are communicated, but also a necessary increase in alternative options for users to transition away from consuming centralised, grid services.

Some sectors are experiencing a shift from centrally-controlled, publicly-owned infrastructure, towards decentralised, privately-owned, individually-controlled service provision. Much of this is driven by the development of new technologies, along with cost reductions and improvements in existing technologies.

For example, Australia is among the world's largest solar PV generators, with approximately two million installations and over 10 gigawatts of generation capacity.⁷² Australia's rate of uptake is world leading, with three quarters of this capacity coming from private residential sources, and penetration exceeding 50% of rooftops in some urban areas.⁷³

Supported by government subsidies through the Small-scale Renewable Energy Scheme and generous feed-in tariffs, solar generation has become an integral part of Australian households' efforts to reduce their power bills and lower their emissions.

Beyond solar panels, smartphones, ridesharing and electric vehicles are some of the tools that are increasingly becoming available to households and business. These technologies can provide greater choice and control over infrastructure costs, even allowing some consumers to become net service providers and revenue generators.

However, despite falling costs (particularly for solar PV panels), not all users have the access or the means to afford these new technologies. There is a risk that high upfront costs, or an inability to adopt or invest in them for other reasons, could disadvantage some groups. For example, disadvantaged Australians are more likely to live in a rental property, and are therefore unlikely to install a solar PV.⁷⁴

There is a risk that users who fail to take up new technologies remain reliant on existing networks, and therefore are left to bear an increasing burden of fixed costs of legacy infrastructure. For publicly-owned networks, the risk is that taxpayers will shoulder a growing share of these costs. The challenge for governments is that cost-saving technologies may not be reasonably available to all users, and the benefits of improvements in infrastructure delivery may be concentrated among those who can afford to make large upfront investments.

8. Opportunity

Some users have limited information or understanding of the costs associated with their use of infrastructure, however new technologies will increase information and control for those that can afford them. New technology will increase transparency of infrastructure costs for users and provide the opportunity for consumers to invest in alternatives to substitute or replace traditional services.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



3.4 Infrastructure for fast-growing cities

At a glance

Sydney, Melbourne, Brisbane and Perth are absorbing three-quarters of Australia's population growth, which is putting legacy infrastructure networks in these cities under increasing strain.

This section explores:

- the challenge of planning for the future using unreliable population forecasts
- how infrastructure could do more to provide better access to vital services and opportunities for some groups of disadvantaged people, including Aboriginal and Torres Strait Islander peoples

Growth and opportunities in our cities have attracted millions

The scale, dynamism and growth of Sydney, Melbourne, Brisbane and Perth make them unlike other Australian cities or regions. Their success has attracted millions of new residents, drawn by the prospects of employment and opportunities to improve their wellbeing. The scale and pace of growth of cities of these four cities has not been seen in Australia for more than half a century:

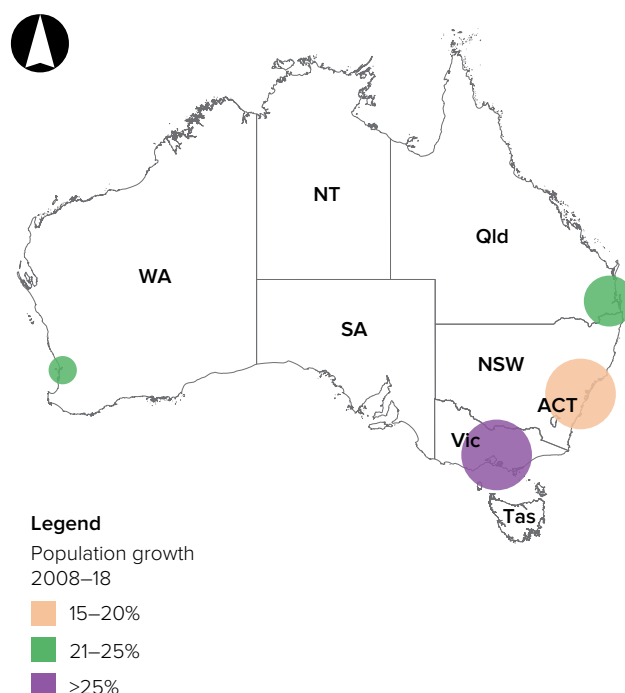
- 59% of Australians now live in these cities.
- Another 11% of the population live within commutable distance of these cities and are able to access the services and opportunities they offer.
- Between them, our four largest cities add more than 280,000 people each year – the equivalent of adding a city the size of Geelong or Wollongong.
- Annual population growth in these cities accounts for almost three quarters of Australia's total.
- This continues a longer term trend, with around 72% of Australia's growth – 2.7 million people – being concentrated in these cities from 2008 to 2018.⁷⁵ Over that time, these four cities have grown by 22% (Figure 7).

These cities have developed as our economic powerhouses in the 21st century, accounting for more than 60% of national GDP. Sydney and Melbourne alone account for almost half of the Australian economy's total output by value.⁷⁶ Their strength is based on the economies of scale they provide, typically lower costs for goods and services, higher levels of competition and access to services and diverse workforces. People and businesses in cities also benefit from their proximity to others with different skills and knowledge, enabling easier exchanges of ideas and technology, and accelerating improvements in productivity.⁷⁷

Population density of fast-growing cities is also in contrast with the rest of Australia. In 2017, Australia's average population density was 3.3 people per square kilometre, one of the lowest in the world.⁷⁸ On the other hand, inner-city Melbourne was the most densely-populated area in Australia, with 20,700 people per square kilometre, while seven of Australia's top ten most densely-populated areas were located in Greater Sydney.⁷⁹ Between 2011 and 2016, population density increased by 23% in the city centre of Sydney and by 46% in the city centre of Melbourne.⁸⁰

Growth of our four largest cities is expected to intensify over coming decades, with these cities projected to be home to around 29 million people by 2066 under ABS Series B projections. This would represent 67% of our total population. Sydney and Melbourne would each accommodate around 10 million people, while Brisbane and Perth would be around the same size as Sydney and Melbourne today.⁸¹

Figure 7: The population of Australia's fast-growing cities of Sydney, Melbourne, Brisbane and Perth increased by 22% over 2008 to 2018



Source: Australian Bureau of Statistics (2019)⁸²

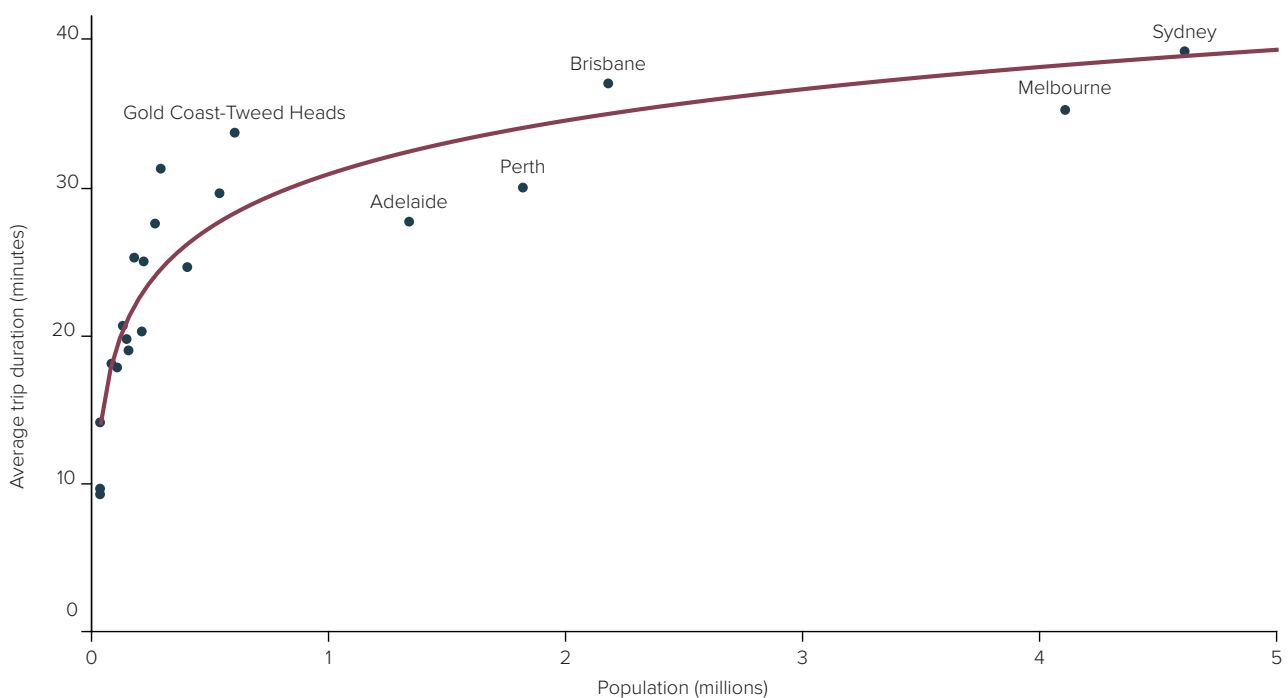
Some urban infrastructure has struggled to keep pace with growth

Australia's urban infrastructure has provided the backbone for much of Australia's growth and transformation over the second half of the 20th century. However, the scale of growth and change in our largest cities requires a rethink of how infrastructure can best meet our needs. This was highlighted in Infrastructure Australia's 2018 *Future Cities* paper.⁸³ Better functioning cities and towns, which focus their attention on planning, lowering poor investment decisions, reducing congestion and adopting efficient planning and land use policies, could deliver a \$29 billion increase in GDP in the long term.⁸⁴ Some of the benefits in that report relate to public infrastructure's contribution to economic growth, including incentives to encourage investment and road provision that meets users' needs. Delivering these improvements may not be straightforward. Many networks were designed decades ago and were never intended to support cities of today's scale, or to meet the needs of our modern population.

There are signs that infrastructure in our cities is not keeping pace with growth and change in demand. For urban residents, road congestion and crowding on public transport are the most visible and frustrating example. Over the last 15 years, growth in public transport demand in Sydney and Melbourne has exceeded population growth.⁸⁵ The annualised costs of congestion in 2016 in Sydney, the Hunter and Illawarra alone is \$8 billion.⁸⁶ As Figure 8 shows, commute times are broadly correlated with population size and are lengthiest in fast-growing cities.⁸⁷

Average commutes times have also grown as high-paying jobs have become more concentrated in city centres. This is exacerbated by limited housing supply close to city centres.⁸⁸ Road congestion and public transport crowding are estimated to have cost the Australian economy \$19.0 billion in 2016, and without action, this figure could grow to \$39.6 billion by 2031.⁸⁹ Of course, this figure likely fails to capture the full social cost of congestion and crowding, which takes its toll on individual users, as well as the environment.

Figure 8: Commuting times for all modes in Sydney, Melbourne and Brisbane exceed other cities



Source: Bureau of Infrastructure, Transport and Regional Economics (2016)⁹⁰



9. Challenge

Rapid growth in Sydney, Melbourne, Brisbane and Perth has brought many benefits, but has also put legacy infrastructure under increasing strain. Without action, infrastructure constraints will add to economic, social and environmental costs, eroding the productivity of these cities and reducing quality of life for residents.

When this will impact:



Where this will impact:

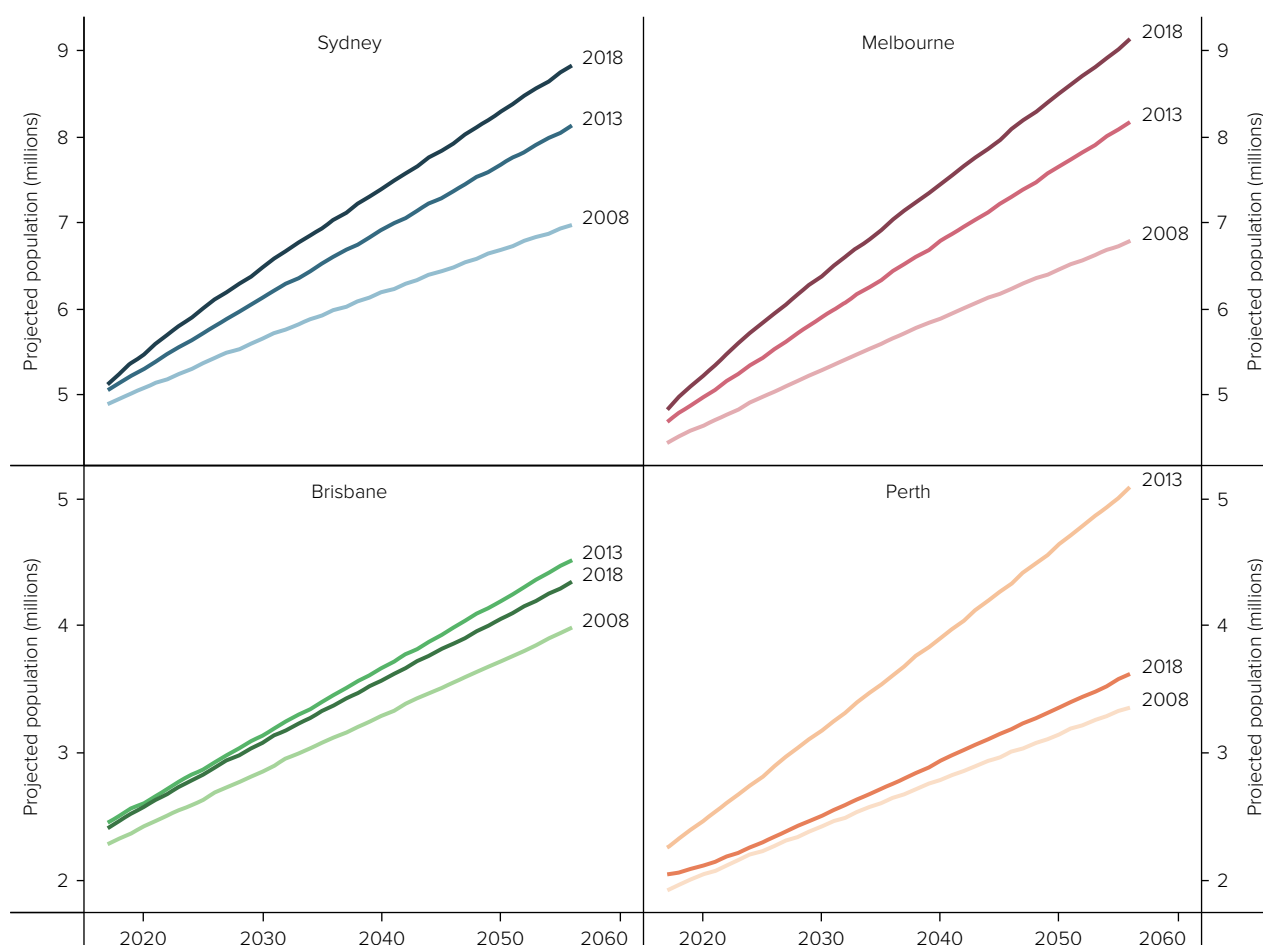


Unreliable population forecasts make infrastructure planning difficult

As Figure 9 shows, population projections for Australia's fast-growing cities have shifted substantially over the last 10 years. Projections for Sydney and Melbourne have consistently underestimated the rate of growth in those cities,

while the 2013 projection for Perth considerably over-estimated growth, based on the influx of people in the previous years during the mining and resources construction boom.

Figure 9: Population projections for major cities have proven unreliable



Note: Each line refers to an individual edition of the Australian Bureau of Statistics's population. Projections presented are for Series B.

Source: Australian Bureau of Statistics (2008, 2013, 2018)⁹¹

The lack of reliable and consistent population projections reduces governments' capacities to plan for future infrastructure needs, based on considered spatial planning. Infrastructure Australia has previously identified this issue, and we have recommended that the Australian Government establish a process to better strategically plan for Australia's population, including the ability to map

this growth onto local areas.⁹² Improved population planning coordination across all levels of government is relevant as all hold important data and levers for decision making. The property sector could also support more informed discussions and decision making. Decisions on infrastructure funding could then be made using a common framework and understanding.

10. Challenge

Unreliable and inconsistent population projections makes planning for future needs difficult. This uncertainty may undermine confidence in infrastructure investments, or delay vital network upgrades to meet future growth, reducing long-term productivity and liveability of our fast-growing cities.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Providing accessible and inclusive services in fast-growing cities

Accurate population projections provide an opportunity for governments to consider how to best support all people in our cities. This includes people with disability, those from culturally and linguistically diverse backgrounds, older people, and others who experience disadvantage, many of whom rely on various public infrastructure services to support their lives. Many areas on the outskirts of fast-growing cities contain some of Australia's most disadvantaged suburbs. These areas are some of the most poorly serviced urban areas by transport, and have limited access to social infrastructure, including health, education and green space.⁹³ For example, 56% of people in the outer suburbs of cities are beyond walking access to medium-to-high frequency public transport.⁹⁴ In inner-city sectors this number is just 4%.⁹⁵

Our major cities are also home to over one third of all Aboriginal and Torres Strait Islander peoples,⁹⁶ who are over-represented among people experiencing homelessness.⁹⁷ However, improving access to health services that are Aboriginal and Torres Strait Islander-owned or managed can assist in achieving health equity, and contribute to culturally appropriate health services.

Infrastructure that connects people to each other through Aboriginal and Torres Strait Islander culture and language can foster greater connections and understanding, as well as providing more business, employment and leadership opportunities for Aboriginal and Torres Strait Islander people.

11. Challenge

In fast-growing cities, many of our most vulnerable or disadvantaged groups, including Aboriginal and Torres Strait Islander people, suffer from poor access to services. This can reinforce disadvantage and limit opportunities for improvements in quality of life through vital links to employment opportunities, education, health, recreational and cultural facilities, and other services.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



3.5 Infrastructure for smaller cities and regional centres

At a glance

This section shows the unfulfilled aspirations for growth amongst smaller cities and regional centres:

- Satellite cities benefit from being close to larger cities, and can support growth almost at once.
- Smaller cities can be highly attractive, with their liveability encouraging growth.
- Regional centres are becoming increasingly important service hubs, providing employment, health care and other key services for surrounding areas.

Types of smaller cities and regional centres

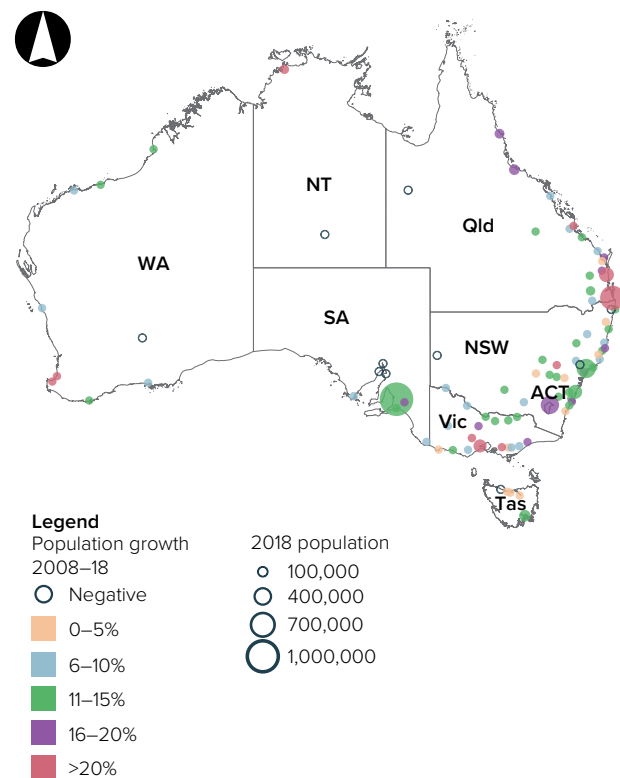
- **Smaller capitals:** Capital cities in lesser populated states and territories – Adelaide, Canberra, Hobart and Darwin – are defined as smaller capitals. These cities generally have lower growth rates than fast-growing capital cities, and have less dynamic economies with relatively fewer dominant industries. These cities service a substantial network of surrounding towns.
- **Satellite cities:** Situated within commutable distance of fast-growing cities, satellite cities typically share major services, such as airports, water supply and major hospitals, with their larger neighbours. Including cities such as Newcastle, Wollongong, Geelong, Sunshine Coast, Gold Coast, and Bunbury, their populations typically decline on weekdays as some locals commute to work in the larger city, and swell on weekends with visitors from the city.
- **Regional centres:** The major service centres in regions are termed regional centres. Many of these places rely heavily on one or two dominant industries, many of which have developed over many decades or centuries. Regional centres include Bendigo, Tamworth, Toowoomba, Alice Springs and Kalgoorlie.

Figure 10 shows where these cities and centres are distributed, as well as their recent population growth.

Smaller capitals and satellite cities have room to grow and develop

Compared to our fast-growing cities, many of our smaller capitals have the capacity to expand their populations without requiring substantial infrastructure upgrades. However, it should be noted that existing infrastructure capacity within these cities can often play a supporting role for the regions surround the smaller capital, so this demand should also be considered. Growing these cities could reduce the strain on cities like Sydney and Melbourne and provide greater sustainability for dispersed regional populations.

Figure 10: Smaller cities and regional centres are dotted across Australia



Source: Australian Bureau of Statistics (2019)⁹⁸

Satellite cities around our major centres could also play an important role in becoming both service centres and new residential precincts for their larger neighbours. In addition to road and rail connections, satellite cities often share other infrastructure networks with major cities. As a result of these connections, it would be less costly to grow satellite cities than smaller cities with less proximity to major cities. Planned well, these satellite cities can be more than dormitory suburbs to larger cities – they can grow into centres of economic and cultural development in their own right.

However, as with fast-growing cities, it is important that growth in our small capitals and satellite cities is well planned and reflective of the community's expectations. This highlights the importance of place-based planning to reflect each area's unique characteristics and comparative advantage. *Greater Geelong: A Clever and Creative Future* is an example

of policy-led development of a satellite city. The strategy presents a place-based approach that explicitly builds on Geelong's existing strengths.⁹⁹ One of these strengths noted is the city's proximity to Western Victoria and Melbourne, which provides two-way access to markets and investment for the city, and thus underpins the strategy.¹⁰⁰



12. Opportunity

Smaller capitals and satellite cities have capacity to grow, and in turn take pressure off infrastructure in our fast-growing cities. Satellite cities can support growth by leveraging the infrastructure of their fast-growing neighbours and smaller capitals, through leveraging infrastructure designed to support their surrounding region.

When this will impact:



Where this will impact:



The liveability of smaller cities is fundamental to their growth

Many of our smaller cities have unique culture, history and identity. The location of smaller cities has been influenced by the settlement patterns of First Australians, early European settlers and our varied natural landscapes and resources. These smaller capital cities and regional centres have since grown around specific industries and purposes. This has forged distinct relationships between local residents, their local environment and their place in Australian society.

Although some smaller cities are becoming increasingly attractive for residents, better infrastructure services are crucial to support further

growth. This is not always easy to provide, as many regional centres are disconnected from major cities and therefore lack scale and competition in infrastructure markets. Over time, this could lead to a growing gap of liveability in some areas, where some communities risk being left behind.

For example, water in regional centres is essential for a range of purposes, including agriculture, recreational parks, the natural environment and citizen's health. If these cities have lower levels of water security than fast-growing cities due to their smaller scale, then they are at greater risk of water restrictions. Over time, this could lead to declining amenity and health outcomes and significantly impact the liveability of smaller cities.

Broome Growth Plan 2017

Broome is a strategic regional centre located in the north of Western Australia, with a population of approximately 16,000 people. In 2015, the Western Australian Government identified Broome as a tranche 1 regional centre that was required to support its own growth and provide links as a spatial network across the State. The *Broome Growth Plan* presented an opportunity for Broome to define its future, using the framework provided by the State Planning Strategy 2050. The Broome Growth Plan also aligns with Recommendation 4.1 of the 2016 *Australian Infrastructure Plan*, which states that state and territory governments should deliver long-term regional infrastructure plans.¹⁰¹

The Growth Plan is a unique strategy and action program that provides an evidence-

based 'operating manual' to achieve sustainable economic growth and generate strong jobs growth in Broome. It aligns with existing state and local government policy and local Yawuru community plans, and fits within the overarching framework for state and regional planning.

The Plan contains clear and considered measures and metrics of success, and identifies four pathways for the implementation of the initiatives listed above: building small enterprise, connecting to governance structures, connecting initiatives and enablers, and infrastructure required. These pathways are used to show what specific activities need to be undertaken in the short and medium term, to achieve the long-term outcomes.

Source: Kimberly Development Commission¹⁰²

Regional centres are becoming increasingly important service hubs

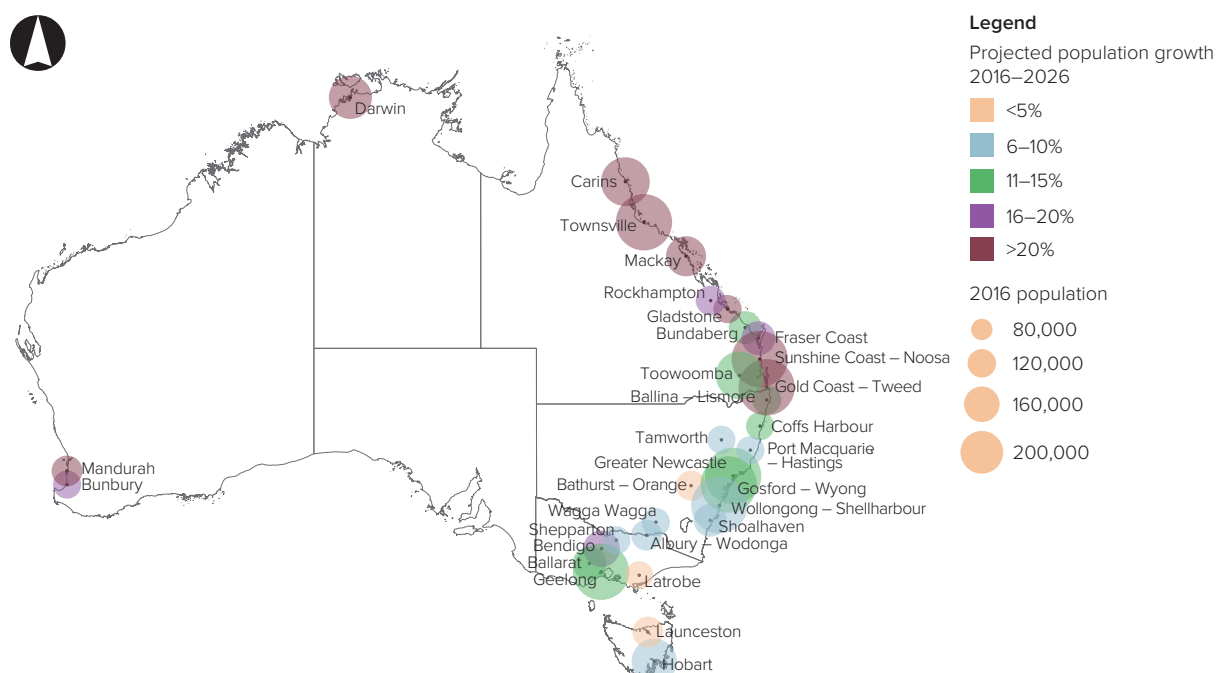
Regional centres provide essential services for local residents as well as surrounding regions. This has been a growing trend, driven by increasing service complexity and specialisation, which is reliant on access to specialised skills and resources, as well as adequate demand levels to warrant and sustain their provision.

As service hubs, regional centres provide centralised access to infrastructure, employment, education, health care and services for the surrounding region. Over recent years, many regional centres have become increasingly important to their surrounding regions, driven by increased specialisation and rationalisation of service delivery across a number of sectors, and enabled by advances in digital connectivity. In many areas, this hub-and-spoke model has improved the flow of workers, service users and consumers between regional centres and surrounding towns. This will help many regional centres to grow strongly in coming years (Figure 11).

Canberra is an example of a regional hub that services a broader surrounding region, including southeastern New South Wales. Canberra is a hub for employment, transport, services and business opportunities and is continuing to grow. However, given the role that Canberra plays in providing services to the surrounding region, including to people who live outside the Australian Capital Territory, planning for adequate infrastructure and identifying relevant investment is difficult and future requirements are hard to quantify.

Key infrastructure in regional centres can also help attract businesses and other service providers to particular regions. For example, regional universities and regional hospitals contribute to the local skilled worker population, and contribute to economic growth. They attract private sector business, such as research institutions, other private education or health services, and other population supporting activities such as hospitality and retail.

Figure 11: Many regional centres are projected to grow strongly over the coming years



Note: Projected population growth figures are sourced from state projections.

Source: Regional Capitals Australia (2017)¹⁰³

The economic characteristics of many smaller cities are changing

Infrastructure has forged a role in supporting the growth and development of smaller cities:

- In cities that have developed around resource-extraction, such as Ballarat, Maitland, Kalgoorlie and Emerald, infrastructure has provided the means of transporting goods to local, national and international markets.
- Freight networks have also been essential for the development of centres forged on agricultural ties, such as Armidale.
- For cities with a history in manufacturing, such as Whyalla and Wollongong, infrastructure has provided much-needed energy for factories and heavy industrial processing.
- In more isolated cities, such as Broken Hill and Mount Isa, infrastructure has provided essential connectivity to and communication with other towns, people and markets.

However, many of these cities are undergoing structural changes as the Australian economy continues to move away from goods-producing industries and shifts towards service-oriented industries. The smaller scale

of economic activity in these cities, and their ties to a single, dominant local industry presents challenges in managing economic fluctuations or structural changes, and providing sustained employment for local workers.

Many businesses are taking advantage of new export opportunities, while others are becoming more exposed to the forces of international competition and globalisation, especially those that are competing for imports. Businesses across a range of industries are also experiencing disruption by new and existing competitors. In response, many businesses are investing in more efficient technologies to improve productivity, though this often comes at the expense of demand for local labour. As a result these labour market dynamics and shifts in population are causing a shift in population, and the infrastructure needs of some regions are changing.

So while growth in the Australian economy has provided opportunities for employment across a range of regional areas, some have been left behind. Consequently, populations have tended to move away from smaller regional communities into larger towns or capital cities. This has obvious implications for the long-term sustainability of local government revenues and the funding of equitable levels of some infrastructure services.

Transition in Traralgon, Victoria

Traralgon is located in the Latrobe Valley, southeast of Melbourne. For many years, Traralgon and surrounding towns have relied on the power generation industry as the major source of employment.

Private owners of the Hazelwood Power Plant announced in 2016 that the plant would be closed in March 2017. Closure of the power station resulted in significant local job losses for residents in Traralgon and other towns in the region.

The closure of Hazelwood has prompted Traralgon to reconsider the infrastructure it requires to

support its future. The Latrobe Valley Authority was established in 2016 by the Victorian Government to manage the transition to a more diverse business sector in the region, and bring together the strategies and plans for future development across the region.

In addition, the Latrobe Valley Supply Chain Transition Program was established to support businesses and workers to transition following the Hazelwood closure. Federal government assistance was also provided to the region to support infrastructure provision, re-skill workers and diversify the regional economy.¹⁰⁴

13. Challenge

Developments in the economy, regulation, technology and service delivery mean our infrastructure needs are changing, leaving some regional centres at risk of being left behind. Lags in infrastructure quality and access to services in smaller cities and regional centres could lead to a growing gap in productivity and liveability, relative to larger cities.

When this will impact:



Where this will impact:



3.6 Infrastructure for small towns, rural communities and remote areas

At a glance

Over 3.2 million people live in remote areas. Their infrastructure needs are vast and varied, and service quality is often poor. Connecting these people to the rest of the country is vital to their lives and economies, especially in Aboriginal and Torres Strait Islander communities that face entrenched inequality.

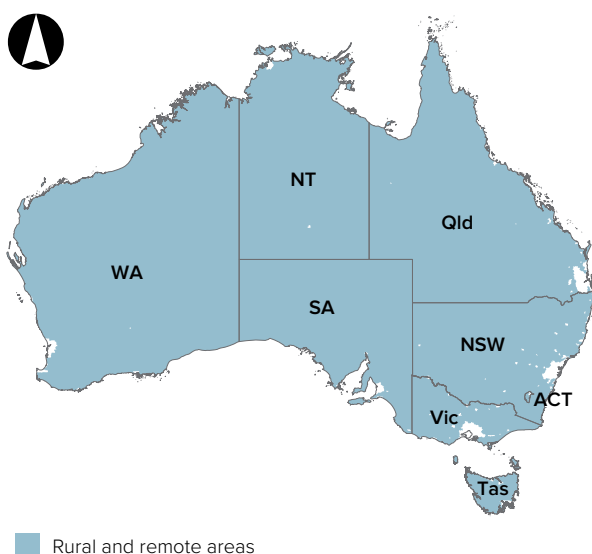
This section finds that remote infrastructure can be improved by consulting communities, designing services based on their needs and setting integrated service policies to improve wellbeing.

Few people live across much of the country

Small towns, rural communities and remote areas are defined as having populations of fewer than 10,000 people, as well as those areas between communities, where small pockets of population often reside on small tracts of land. These places cover most of Australia's land mass (Figure 12).

This geographical classification is broad, and the needs within these towns and communities are diverse. For example, it includes Castlemaine, which is about a 30-minute commute to satellite city Bendigo in Victoria. This category also includes Kiwirrkurra, a community of around 150 people in the Gibson Desert of Western Australia, which is about a 15-hour drive to its nearest regional centre of Alice Springs – one of the most remote communities in Australia.

Figure 12: Small towns, rural communities and remote areas cover most of Australia's land mass



Note: This map shows all land excluding all Significant Urban Areas,¹⁰⁵ and the four Greater Capital City Statistical Areas for Sydney, Melbourne, Brisbane and Perth.¹⁰⁶

While most Australians live in fast-growing cities (59%) or smaller cities and regional centres (29%), over 3.3 million Australians (12%) live outside these urban centres.¹⁰⁷ One in ten Australians live in small towns with populations of fewer than 10,000.¹⁰⁸ At the time of the 2016 Census:

- 88 towns had populations of 5,000 to 9,999, and were home to 613,500 people
- 526 towns had populations of 1,000 to 4,999, and were home to 1,147,400 people
- 1,088 communities had populations less than 1,000, and were home to 518,600 people.¹⁰⁹

Outside our cities, infrastructure needs are vast and diverse

The nature of many of Australia's smaller towns has changed dramatically over their history since European colonisation. Over recent decades, a range of factors has diminished economic opportunities in many of these towns.

Shifts in Australia's industrial composition, in addition to technology and productivity advancements, have led to a loss of employment in many areas. Many rural and remote regions have declining populations in contrast to the modest growth in the majority of Australia's smaller cities and regional centres.¹¹⁰ In many smaller towns, services that urban residents take for granted have consolidated to larger regional centres, driven by a range of factors, including changing demand, technological change and improved digital connectivity.¹¹¹

Remote infrastructure faces distinct risks and challenges, including:

- **High costs of construction**, sometimes compounded by vast distances with low population density, limited local workforces, and significant challenges of attracting workers to remote projects,¹¹² leading to reduced competition in the market.
- **Difficulty producing compelling economic modelling** to justify investment, especially as costs are higher, and potential users are fewer and more dispersed. Forecasting future demand is more difficult due to uncertainty and exposure to external forces, such as changes in consumer preferences, exchange rates, trade flows, and agricultural and mineral commodity prices.¹¹³
- **Exposure to extreme climate and weather events**, including drought, bushfire and flood, bringing considerable resilience risks. Rural and remote areas can be more vulnerable to the risks of natural hazards, and greater investment may be required to protect or maintain these assets.
- **Reliance on single assets and networks**, with limited choice for users and increased likelihood of redundancy or asset failure.

Connectivity is essential for remote communities

Connectivity, both in a physical and digital sense, is perhaps the most pervasive and critical issue for remote communities and people in rural areas. The access, quality and cost of transport and telecommunications links – or perceived risks of future deterioration – can influence decisions to set up new businesses or invest in regional areas.

Connectivity and access to services also has a major role in influencing decisions by individuals and households to move to or stay in regional areas. Young people with poor access to employment opportunities, education and entertainment may not see a future for themselves in regional areas, depriving regional businesses of their skills. Also, older people without access to health facilities or telehealth services may not feel comfortable staying in regional areas, depriving regional communities of service employment opportunities, as well as their contribution to local communities through experience and cultural activities.

Service quality in many small towns and remote communities is poor

The cost, quality, and accessibility of services is fundamental to community wellbeing, and has a direct relationship to the productivity of its local economy. When small towns are supported, communities can more successfully meet economic challenges and better adapt to structural change.¹¹⁴ For younger generations to see a future for themselves outside our major cities, they must also see that these places will offer similar high-quality services, and not have to compromise on liveability or connectivity. However, gaps in service delivery between major cities and many small towns are widening.¹¹⁵

Providing accessible and continuous health care is a challenge in rural and remote areas. These areas also have limited access to specialist's acute care and the infrastructure to support these services.¹¹⁶

Other services, while accessible, may be unreliable or low quality. For example, the *2018 Regional Telecommunications Review* found that, for some people, the NBN Co satellite service, Sky Muster, is falling well short of their current needs and expectations.¹¹⁷ The provider's service quality expectations also lowered with increasing remoteness, with 10% non-supply deemed acceptable in rural areas.¹¹⁸ On average over the last five years, this represents approximately 10,000 premises annually, which could equate to 30,000 people impacted each year.

Transport infrastructure has profound effects on settlement patterns. However, the vast distances between communities in many rural areas mean that many users suffer poorer quality services and reduced physical connectivity.

For example, the operation of regional aviation services is more challenging than for routes between capital cities, principally due to difficulties in achieving economies of scale in regional markets.¹¹⁹ This is particularly important given regional airports had on average a 6% funding gap between their expenditure required to operate the airports and revenue collected in 2014-15,¹²⁰ and nearly 40% of regional airports expect to experience persistent budget deficits in the 10 years.¹²¹

In part, this issue is addressed through the Regional Aviation Access Programme, which provides support for aerodrome infrastructure and air services to remote areas where they are not commercially viable.¹²² However, many regional destinations, particularly in northern Australia, have higher airfares and far less frequent connections than regional areas in the south.¹²³



14. Challenge

Infrastructure is more expensive to provide per unit of consumption in low population density areas, but communities and businesses in these areas are also more reliant on available infrastructure for their productivity and wellbeing. Poorer infrastructure services in small towns, rural communities and remote areas could lead to limited opportunities for growth and may undermine the long-term viability of some communities.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Challenges in regional areas hamper infrastructure delivery

Infrastructure provision to support regional industries comes with distinct challenges, including:

- Low population densities and vast distances between communities
- Higher costs of construction, operation and maintenance of assets, and greater scale of assets required to connect communities
- First-mover disadvantage for regional businesses to invest in new or upgraded infrastructure, and a lack of capacity among existing communities and industries to fund projects.

These factors increase risks for regional proponents and may undermine the economic case for investment in regional infrastructure. Even where investment per capita in regional infrastructure exceeds the cities, this may not be sufficient to overcome the impact of these challenges. As a result, access, quality and cost of infrastructure required for regional industries across many parts of the country have suffered. For example:

- Poor mobile reception that does not extend beyond places of residence, and low-capacity, unreliable broadband, limiting capacity to embrace data-reliant technologies on farms
- High transport costs, driven by large distances, poor supply chain efficiency, and limited access for heavy vehicles on some routes due to weight restrictions and ageing bridges
- Poor transport reliability with roads and railways susceptible to flooding and deterioration
- Little or no public transport, and high costs of air travel, limiting access to workers
- Limited access to potable water and wastewater services, or reliable and secure water to support agriculture, mining and manufacturing
- High energy costs, limited access to reliable fuel sources and, in some cases, a need to truck in diesel for generators
- Limited access to adequate and modern health, education, housing and other services.



15. Challenge

Regional infrastructure faces a range of unique challenges and risks, which make it difficult to efficiently provide services that support growth in regional industries. Failure to overcome the challenges and risks facing regional infrastructure raise costs and barriers for investment in regional industries, limiting opportunities for employment and growth, and eroding confidence in the future viability of some areas.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Infrastructure is critical to supporting Aboriginal and Torres Strait Islander communities

Australia is the home of the oldest continuous culture on the planet, with evidence that Aboriginal and Torres Strait Islander people inhabited the land for at least the past 65,000 years. Over this time, First Australians cared for country by using land management that worked with the environment. Using traditional practices, they were able to create a system that was sustainable and supplied them with the food and resources they needed.

Infrastructure decision makers can learn from the traditional owners of the land, in terms of sustainability, managing our footprint and harnessing our natural habitat. However, providing infrastructure to support Aboriginal and Torres Strait Islander peoples – particularly in remote communities and areas – remains one of Australia's most considerable, and long-lived infrastructure challenges. Infrastructure can help to overcome the disadvantage and inequality suffered by these communities, and improve their welfare through better health and education, while providing opportunities for employment and the development of local industries.

While the largest concentration of Australia's Aboriginal and Torres Strait Islander population are found in urban areas, there are more Aboriginal and Torres Strait Islander people than other Australians living in remote areas. Approximately 20% of all Aboriginal and Torres Strait Islander peoples live in rural and remote areas, compared to only 1.7% of other Australians.¹²⁴ The Australian Bureau of Statistics estimates that the 2016 Census undercounted Aboriginal and Torres Strait Islander peoples by 17.5%, or 137,750 people.¹²⁵

More than a decade ago, the Council of Australian Governments committed to decreasing inequality between Aboriginal and Torres Strait Islander peoples and other Australians through the Closing the Gap targets.¹²⁶ However, only two targets, early childhood education and Year 12 attainment are on track to be met. Targets in relation to child mortality, school attendance, life expectancy, reading and numeracy, and employment are not on track.¹²⁷ Improved infrastructure services are critical to providing the necessary services to address this disadvantage.

Peninsula Development Road, Cape York, Queensland

The single integrated 527 kilometre Peninsular Developmental Road between Lakeland and the Rio Tinto Boundary, south of Weipa, aims to improve access to regional and remote Cape York communities. The \$276 million project began in 2014, and is jointly funded by the Australian Government and the Queensland Government.¹²⁸ When completed, the road could help unlock the potential of local industry, increase the liveability of the area, increase road safety standards, improve freight efficiency and strengthen the local economy.

The project will also provide \$50.5 million for targeted assistance for the development of Indigenous businesses and infrastructure.¹²⁹ This includes infrastructure identified by the Torres Cape Indigenous Council Alliance including road, barge, boat ramps and sewerage infrastructure.¹³⁰ Embedding indigenous participation into this infrastructure project has increased economic development and helped local people find employment. In 2018, it was estimated that 54% of the workforce on the Peninsula Development Road were Aboriginal or Torres Strait Islander, and 27 Aboriginal or Torres Strait Islander businesses were involved.¹³¹

16. Challenge

Infrastructure can do more to support Aboriginal and Torres Strait Islander peoples in remote communities and rural areas, and to underpin progress towards local and national objectives for improving quality of life. Failing to improve services for First Australians in remote communities and rural areas undermines potential improvements in quality of life and reinforces gaps in inequality and disadvantage.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



3.7 Infrastructure to support regions and unlock growth in northern Australia

At a glance

The right infrastructure can unlock growth in regional industries, but delivery can be challenging due to low populations, challenging weather, changing markets and high building costs. Boom-and-bust economic cycles add more difficulty, but adaptive infrastructure can help stabilise them.

Northern Australia is particularly prone to these challenges, yet it has significant economic potential. Infrastructure can help access this opportunity. Governments can support development by drawing on:

- current research, including from CSIRO and Geosciences Australia
- lessons from past development efforts.

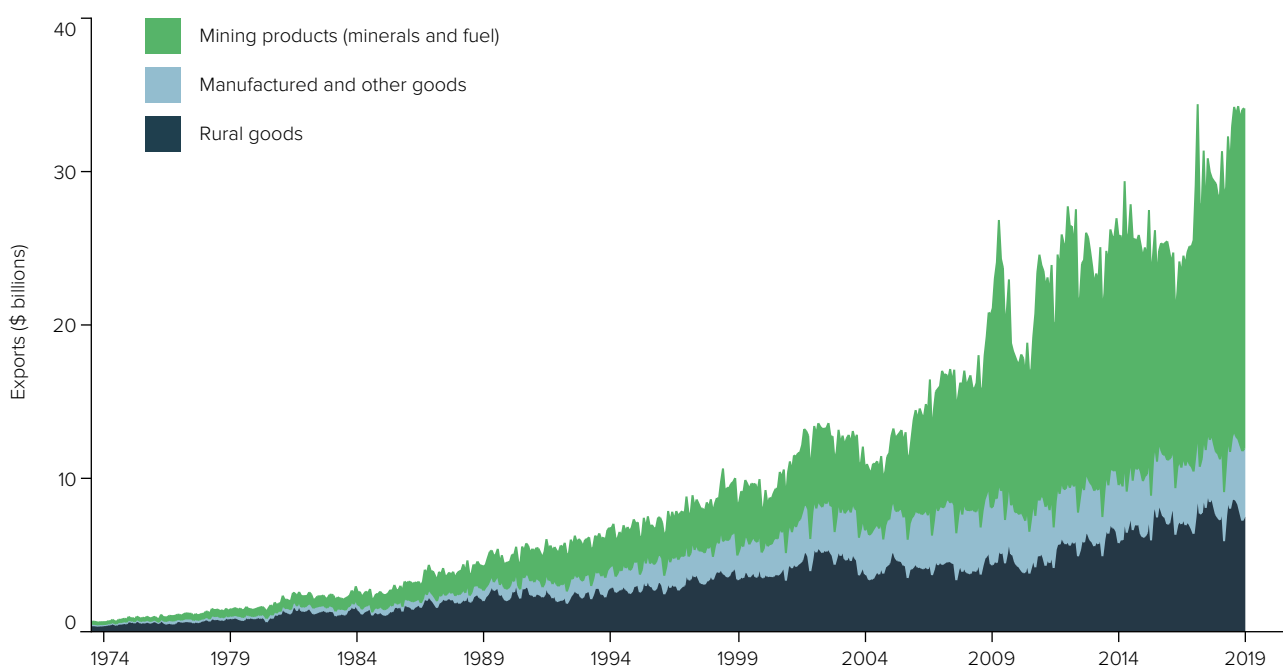
Infrastructure provides vital links for regional industries

Beyond providing services to users, infrastructure also supports industries. The right infrastructure in the right place at the right time can catalyse industry growth by improving connectivity and competitiveness. These areas encompass smaller cities, regional centres, small towns, remote communities and the areas in between. Many regional areas rely on few dominant local industries, which often provide a large proportion of local jobs and income.

Regional infrastructure has been driven by its economic history. Drawn by the opportunities provided, regional Australia in 1911 was home to 60% of the population, with 45% of Australians living in towns of greater than 200 people, and 15% in small localities and rural areas.¹³²

Many of Australia's regions are highly productive and prosperous. Average incomes can often be higher than cities, especially in mining regions, providing high levels of tax revenue. In the year to November 2018, over 85% of Australian goods exported were rural goods or mining products. Figure 13 shows how exports for these industries have grown rapidly in recent decades.

Figure 13: Exports from mining and rural goods have grown dramatically over recent decades



Source: Australian Bureau of Statistics (2019)¹³³

Infrastructure can support regions in transition

Infrastructure's role as a supporter of industrial activity is especially important in regions where the dominant source of jobs and output is changing.

Despite facing a number of ongoing long-term economic challenges, regions across Australia have, on the whole, shown resilience and generated growth and employment. 77% of regions have experienced positive employment growth over the past five years,¹³⁴ and unemployment in regional Australia is lower than the EU average.^{135,136}

However, many regions are facing drought, global competition for goods and services, structural economic shifts, and new technologies that have displaced some workforces.¹³⁷ Employment growth in capital cities consistently outperforms the rest of the state,¹³⁸ and some regions – particularly those in very remote locations – have struggled to adapt in a changing economy. While real wage growth has been fairly similar across capital cities and regional areas, wage levels are generally higher in capital cities than in regional areas. On average, since 1995–96, those who live in capital cities have earned 17 to 22% more than people who live in the rest of the country.¹³⁹

Infrastructure can unlock opportunities for growth and employment where structural changes have hit hardest, and where the effects of economic change are proving the most stubborn to overcome. In some regions, existing infrastructure networks may be able to adjust to the changing needs of local industries. Across many regions, however, strategic investments and reforms may be required to help local businesses and communities adapt to change, and bring new opportunities for growth and development.

Infrastructure can help to smooth economic fluctuations and cycles

Growth in regional industries can bring employment, income and vibrancy to local communities and surrounding areas. However, this growth can also come with its own challenges and risks for the sustainability of opportunities, especially where growth is driven by a single industry.

The cyclical nature of demand for regional industries, particularly for natural resources, and the sensitivity of demand to global prices and our exchange rate, mean not all growth is long-lived – unlike the infrastructure required to support it. This raises the risks of stranded or underutilised assets that can be a financial burden when activity declines.

Seasonal variations in economic activity also present challenges for efficient and sustainable infrastructure service provision. Some forms of production require specialist labour or assets, which may require additional investment in infrastructure that, due to seasonable variations in demand or production inputs, may be under-used. For example, some regions reliant on irrigated agriculture have undergone significant changes to their land use and crop choice.¹⁴⁰ The shift away from lower-value bulk commodities affects the utilisation of local processing infrastructure, and changes industries' needs from supply chain infrastructure to carrying goods to port or market.

Infrastructure can help to smooth peaks and troughs. Common-use infrastructure that provides digital and physical connectivity, such as roads, airports, mobile towers and broadband access, can boost social capital and support a diversity of growth sectors, including tourism and other tertiary services that tend to be more resilient to economic fluctuations. Education facilities can help to boost local human capital, provide ongoing skills to local businesses and help workforces retrain through structural shifts in the economy.

17. Challenge

Fluctuations in economic activity in regional industries make it difficult for infrastructure to efficiently and sustainably underpin long-term growth and development. Failure to keep pace with growth can reduce productivity and output during boom years, while underutilised assets raise costs in areas with declining populations, undermining the long-term social and economic viability of regional communities.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Northern Australia faces distinct challenges

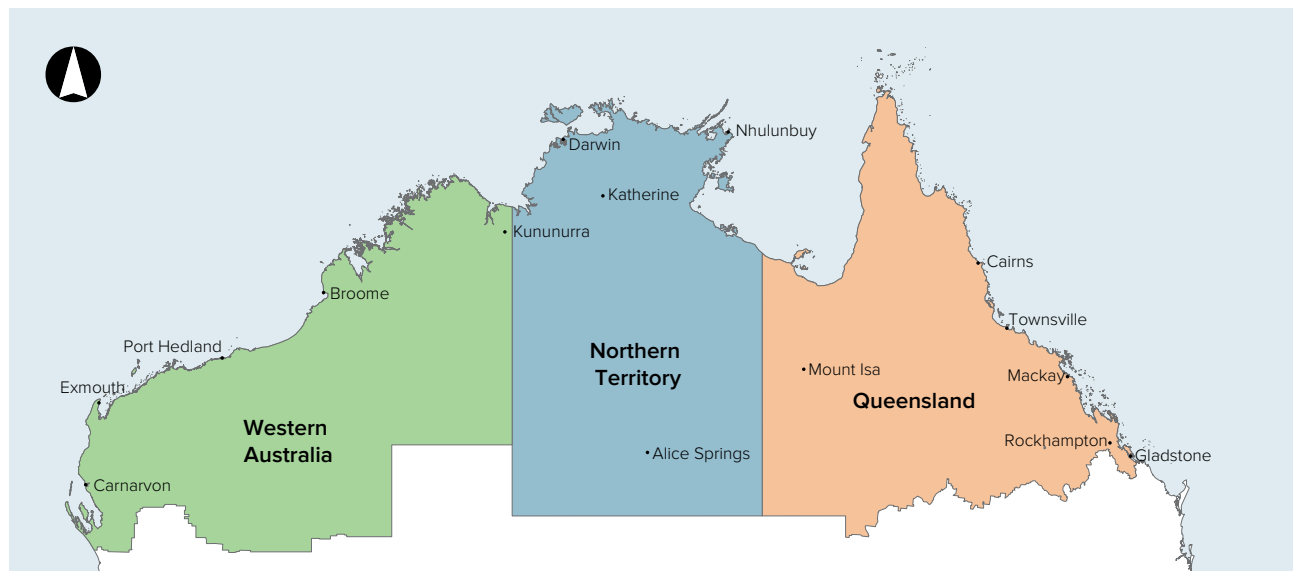
Many of the challenges faced by other parts of regional Australia are amplified in northern Australia, which extends across a large proportion of Australia's land mass (Figure 14). In particular:

- Exposure to more extreme weather and climate impacts, including high temperatures, high seasonal and variable rainfall in tropical regions, and events such as cyclones and floods
- Higher costs of living and doing business, driven by remoteness, lack of scale, and lack of historical investment in transport and essential services
- Higher levels of risk and barriers to investment in some regions, including significant first-mover disadvantage for proponents seeking to establish or extend supply chains to new areas

- Historical lack of coordination in planning and investment across jurisdictional boundaries, resulting in disconnected transport and energy networks and inefficient supply chains
- Higher rates of mobility, as workforces follow projects rather than settle in communities
- Large variation in the quality of life and diversity of needs from infrastructure, particularly in the most remote parts of the country and among Aboriginal and Torres Strait Islander peoples.

These challenges have deterred or slowed development and investment across many northern regions. The combined impact of these challenges is also reflected in the slow rate of population growth in northern regions, particularly since the end of the mining construction boom.¹⁴¹ In 2017-18, the Northern Territory was the only state or territory to experience negative growth, with a rate of -0.1% and a net population decrease of 190 people.¹⁴²

Figure 14: Northern Australia extends across Western Australia, Northern Territory and Queensland



Note: These boundaries are as per the definition of northern Australia in the *Northern Australia Infrastructure Facility Act 2016 (Cth)*.

There is untapped potential for growth in northern Australia

Despite the challenges facing northern Australia – or perhaps because of them – there are significant, largely untapped opportunities for development. Some of our least populous and most remote regions also hold the greatest potential to grow. This is particularly true of regions in northern Australia, where a range of factors contribute to immense potential:

- An abundance of natural resources, including deposits of natural gas, uranium, lead, gold, zinc, silver, tungsten, bauxite, oil, iron ore, metallurgical and thermal coal, and rare earths, as well as other environmental assets
- Large tracts of undeveloped land in a tropical climate, much of which experiences high seasonal rainfalls during the wet season of December to March
- Proximity to rapidly growing and developing Asian markets, with strong demand for our agricultural and mining products, as well as services including education, health and tourism
- Natural beauty, with geographic and topographic features unlike anywhere else on earth, with 65 sites listed in World, National and Commonwealth Heritage Lists, including the Great Barrier Reef, and the Kakadu, Uluru-Kata Tjuta and Purnululu National Parks
- Rich Aboriginal and Torres Strait Islander history, traditions and sites of cultural significance.

This potential was highlighted in the Australian Government's *White Paper on Developing Northern Australia* in 2015.¹⁴³ In support of this work, Infrastructure Australia released the *Northern Australia Infrastructure Audit* in the same year.¹⁴⁴ The process initiated by the White Paper is four years into a 20-year commitment by governments to transform northern Australia and to unlock its substantial potential.

Infrastructure can unlock growth across the northern economy

Infrastructure can play an essential role as a catalyst for growth in northern industries. Improvements in physical and digital connectivity, as well as the development of gateways for trade with domestic and global markets, can also help to open new parts of the country for development. Opportunities for growth include:

- **Agriculture:** A range of forms of production, including pastoral, irrigated and broadacre farming, as well as aquaculture and fisheries
- **Resources:** Further exploration and extraction of existing minerals deposits and natural resources, including iron ore, natural gas, gold and bauxite, as well as new sites containing rare earths that are integral components for batteries and green technologies
- **Energy:** Beyond oil and gas, renewable energy has the potential to grow enormously, both as a supplier of intermittent energy for the domestic market and for the provision of energy for export by connection with growing Asian markets through export of hydrogen,¹⁴⁵ or directly through a high voltage direct current cable to Indonesia¹⁴⁶
- **Tourism:** Expansion of facilities and service offerings for local, domestic and international tourists, including growing links with cruise routes through south-east Asia, and development of tourism to showcase local Aboriginal and Torres Strait Islander knowledge, food and traditions
- **Other services:** Provision of services through educational institutions, specialist health care, professional services, and scientific research, particularly in the field of tropical health
- **Space and aerospace:** Potential to grow sites for launch, research and testing of satellites, space and aerospace craft.

Infrastructure needs across these sectors vary, but common outcomes sought are resilience, reliability and efficiency. Given the vast distances between communities and exposure to a volatile and seasonal climate, northern regions need improved connectivity through upgrades to transport and telecommunications networks. Investments in ports, airports, remote aerodromes and other elements of supply chains, such as storage and refrigeration facilities, can open new domestic and export markets for businesses and give local producers opportunities to get their goods to expanded markets more quickly and cheaply.

Improving connectivity for exports can have flow-on benefits for regional areas and their communities. More agricultural exports by air would improve the finances of inbound tourism flights and increase the productivity of other airport infrastructure. Also, improvements in broadband and mobile coverage can support growth of service industries, as well as enhancing access to social services such as remote education and telehealth. These can enhance the liveability of regional communities, helping to attract and retain residents.

Many of these were highlighted in Infrastructure Australia's *Northern Australia Infrastructure Audit*, which provides a comprehensive, ongoing reference guide for infrastructure priorities in northern regions.¹⁴⁷

18. Opportunity

Infrastructure can help to catalyse growth across northern Australia, and unlock development across a range of industries. Improving the resilience, reliability and efficiency of northern infrastructure could help to capitalise on the immense potential of northern regions, and improve the productivity, quality of life and competitiveness of its people and businesses.

When this will impact:



Where this will impact:





Further evidence can support development in the north

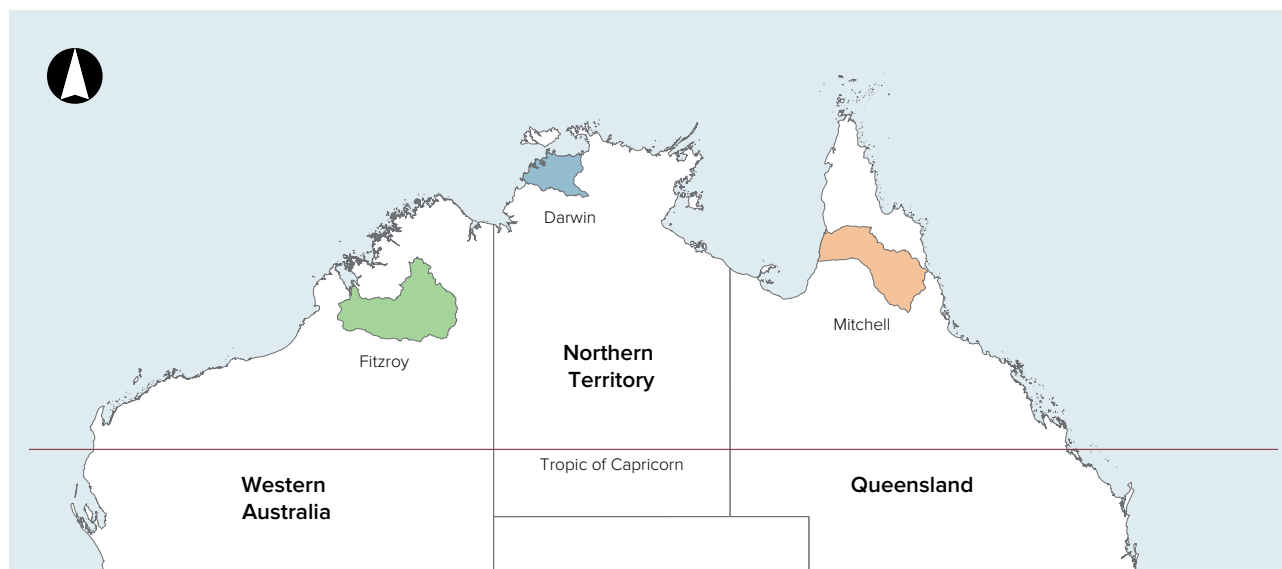
Given the finite resources of governments, it is important to undertake studies to understand how infrastructure can unlock strategic opportunities, and can deliver improvements in outcomes such as improving productivity, sustainability and quality of life, or reducing socioeconomic disadvantage. Examining the economic, social and environmental benefits of potential projects can help to support efficient investment in underdeveloped regions. Supporting this analysis with scenario testing using a range of external factors, such as changes in exchange rate, climate change, and developments in technology can ensure these opportunities are resilient to potential future changes.

Work such as the Northern Australia Water Resource Assessments undertaken by the CSIRO is an example of investigation of the economic prospects of potential development zones and the infrastructure required to support future growth. These studies

looked at the Flinders and Gilbert catchments in Queensland in 2013,¹⁴⁸ and the Fitzroy (Western Australia), Darwin (Northern Territory) and Mitchell (Queensland) catchments in 2018 (Figure 15).¹⁴⁹ This research provides an evidence-based platform for decisions on infrastructure and investment by industry and governments in northern regions.

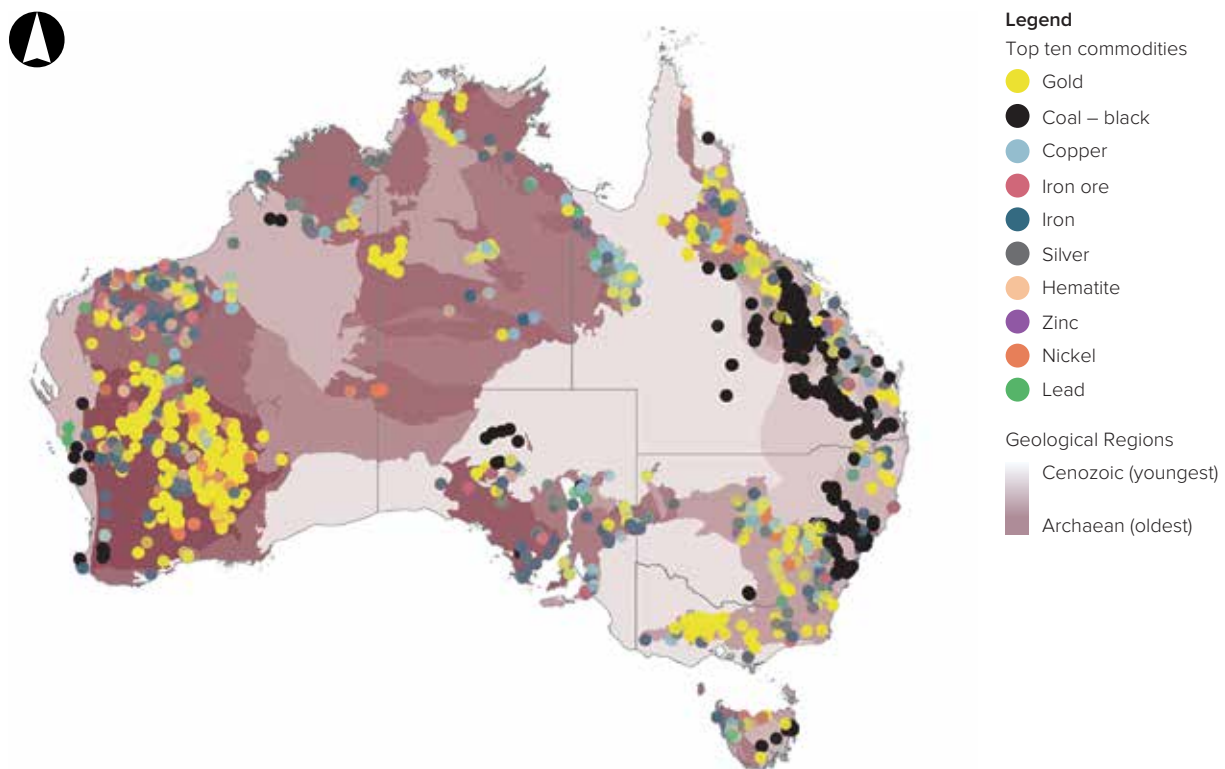
Similarly, work by Geosciences Australia is helping to identify future resource zones by building information on potential mineral, energy and groundwater resources concealed beneath the earth's surface through the Exploring the Future program.¹⁵⁰ This allows businesses and governments to identify and plan for infrastructure to support development and de-risk a range of private sector investments. As shown in Figure 16, Australia is home to a large variety of resource deposits, many of which are clustered in northern Australia.

Figure 15: Studies by the CSIRO in 2018 investigated opportunities for development of three regions across northern Australia



Source: Commonwealth Scientific and Industrial Research Organisation (2018)¹⁵¹

Figure 16: Australia's mineral deposits are spread across the continent, with many clusters in northern Australia



Source: Geoscience Australia (2013)¹⁵²

Past development efforts provide lessons for the future

Governments have committed considerable funding to reinforce the critical infrastructure of rural and remote regions over many years.¹⁵³ A significant proportion of these funds are directed to regional social and economic infrastructure projects. As of May 2017, the Australian Government had committed in excess of \$20 billion in expenditure on regional programs – likely to be a conservative estimate as it excludes projects such as the National Broadband Network and Inland Rail.¹⁵⁴

However, some investments to unlock growth and further investment may have yielded limited benefits. The Productivity Commission criticised ad hoc financial assistance to regions as rarely effective at facilitating transition or long-term development.¹⁵⁵ Other programs may have provided mixed results. For example, between 2008 and 2017, the WA Government's Royalties for Regions program directed over \$6.9 billion of royalties from the state's mining and onshore petroleum activities into more than 3,700 infrastructure and community projects.¹⁵⁶ An independent review found that despite a broad but clear objective to enhance WA's regional areas, it was not clear that the program supported any significant or consistent economic or social progress in WA's

regional development areas.¹⁵⁷ These views were reflected by the WA Auditor-General in an earlier inquiry.¹⁵⁸

Understanding local needs is also important for ensuring development is supported by local communities, especially where developments occur on Aboriginal and Torres Strait Islander lands or impact those communities. Diversity of needs among regions and communities, including distinct cultures, traditions and values of Aboriginal and Torres Strait Islander communities and native title holders, limits the impact of broad, one-size-fits-all approaches to regulation, funding and policy.

Applying place-based thinking to understand these local needs and values often takes time and cost. Frequently overlapping titles, procedures and legislation relating to land use and land title, including different land tenure regimes for mining rights, Aboriginal and Torres Strait Islander land rights, and tenure relating to water access and biodiversity offsets can raise barriers for accelerated investment. While place-based thinking requires more initial investment to design and establish, funding and projects typically have substantially higher success rates and positive outcomes representing substantial value for money outcomes as compared to ad-hoc broad based approaches.



Cape Leveque Road, Western Australia

The Dampier Peninsula, situated north of Broome in Western Australia's Kimberley Region, is a unique location with significant environmental, cultural and heritage values. It is home to 1,500–2,000 people, across four main Aboriginal communities (Ardyaloon, Beagle Bay, Djarindjin and Lombadina) and around 50 small settlements or seasonal camps.

A \$65 million jointly State-Commonwealth funded project is currently underway to upgrade the partially-sealed, 205-kilometre Broome to Cape Leveque Road, which provides the main transport link through the Dampier Peninsula, enabling vehicle access to the Aboriginal communities, tourist destinations, pastoral stations and businesses.

Sealing the Broome to Cape Leveque Road will open up the Peninsula to a much larger range of visitors than is currently possible due to the low quality of the current road and flooding during the wet season. This access is a significant catalyst to unlocking the Peninsula's economic potential. In particular, it will provide new opportunities for Aboriginal people and businesses, pastoralism, aquaculture, and the oil, gas and tourism industries. This is one of the first projects to implement the Western Australia's Aboriginal Procurement

Policy. On average, the project has employed 35 Aboriginal peoples, of which 30 are local.

While this project is likely to bring further economic and employment opportunities in the area, the sealing of the road also opens the Peninsula to a range of potential negative environmental, cultural and social impacts from the greater number of unmanaged visitors and access. Further collaboration with local Aboriginal communities will be important to address these concerns, and improvements to local infrastructure will be needed.

Work is underway to address both the potential impacts and economic opportunities of sealing the Broome to Cape Leveque Road. This highlights the need to consider infrastructure investments both strategically and holistically to maximise the benefits they deliver, particularly in remote and regional areas. Understanding these values and preferences at the outset of the project could have enabled this information to help shape project design and support sequencing of development on the Dampier Peninsula to ensure local communities support the project and are ready to capture the opportunities it brings.

19. Opportunity

Development in northern regions could benefit from more detailed information and evidence-based studies of economic opportunities, as well as a better understanding of local needs and values, particularly of local Aboriginal and Torres Strait Islander peoples. Better information on opportunities and local needs can support more efficient investment and greater benefits for northern communities.

**When this
will impact:**

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15+

**Where this
will impact:**



3.8 Challenges and opportunities

Infrastructure that works for users

1. Challenge

Governments and service providers do not always adequately measure and report on access, quality and costs for users. Insufficient user-focused data makes it difficult for users and policy makers to make decisions that improve user outcomes.

When this will impact:

0-5

5-10

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Where this will impact:



2. Opportunity

Technologies can help to overcome barriers to service access as a result of distance or location. Better access to services through improved technology can bring economic and social opportunities for users outside of fast-growing city centres.

When this will impact:

0-5

5-10

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Where this will impact:



3. Opportunity

User data and customer insights can enable innovation to better meet users' needs. Better understanding users' needs can help operators to improve user experience, attract more users and provide services more efficiently.

When this will impact:

0-5

5-10

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Where this will impact:



4. Challenge

Users that are disadvantaged, such as those with low digital literacy or with disability, may be unable to access infrastructure services provided through new technologies. Not extending the benefits of change to all Australians is likely to increase inequality and reduces quality of life by limiting access to services for some members of the community.

When this will impact:

0-5

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Where this will impact:



Costs and affordability

5. Challenge

Limited reliable data exists to allow government, regulators and users to understand the total costs of infrastructure. Poor data limits the ability for government to understand the affordability of infrastructure services and cost of living pressures.

When this will impact:

0-5

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Where this will impact:



6. Opportunity

Improved collection of data, including by third parties (such as financial institutions) could support improved decision making using big data. Partnering with data owners to support the collection of detailed, up-to-date data, will allow better decision making. However, data privacy will need to be managed.

When this will impact:



Where this will impact:



7. Challenge

User-pays funding for infrastructure has widespread support within the community. However, its regressive nature disproportionately affects low-income earners. Transport, energy, water and telecommunications infrastructure user costs are above affordability thresholds for our lowest income earners thereby reducing access to services and quality of life.

When this will impact:



Where this will impact:



8. Opportunity

Some users have limited information or understanding of the costs associated with their use of infrastructure, however new technologies will increase information and control for those that can afford them. New technology will increase transparency of infrastructure costs for users and provide the opportunity for consumers to invest in alternatives to substitute or replace traditional services.

When this will impact:



Where this will impact:



Infrastructure for fast-growing cities

9. Challenge

Rapid growth in Sydney, Melbourne, Brisbane and Perth has brought many benefits, but has also put legacy infrastructure under increasing strain. Without action, infrastructure constraints will add to economic, social and environmental costs, eroding the productivity of these cities and reducing quality of life for residents.

When this will impact:



Where this will impact:



10. Challenge

Unreliable and inconsistent population projections makes planning for future needs difficult. This uncertainty may undermine confidence in infrastructure investments, or delay vital network upgrades to meet future growth, reducing long-term productivity and liveability of our fast-growing cities.

When this will impact:



Where this will impact:



11. Challenge

In fast-growing cities, many of our most vulnerable or disadvantaged groups, including Aboriginal and Torres Strait Islander people, suffer from poor access to services. This can reinforce disadvantage and limit opportunities for improvements in quality of life through vital links to employment opportunities, education, health, recreational and cultural facilities, and other services.

When this will impact:



Where this will impact:



Infrastructure for smaller cities and regional centres

12. Opportunity

Smaller capitals and satellite cities have capacity to grow, and in turn take pressure off infrastructure in our fast-growing cities. Satellite cities can support growth by leveraging the infrastructure of their fast-growing neighbours and smaller capitals, through leveraging infrastructure designed to support their surrounding region.

When this will impact:



Where this will impact:



13. Challenge

Developments in the economy, regulation, technology and service delivery mean our infrastructure needs are changing, leaving some regional centres at risk of being left behind. Lags in infrastructure quality and access to services in smaller cities and regional centres could lead to a growing gap in productivity and liveability, relative to larger cities.

When this will impact:



Where this will impact:



Infrastructure for small towns, rural communities and remote areas

14. Challenge

Infrastructure is more expensive to provide per unit of consumption in low population density areas, but communities and businesses in these areas are also more reliant on available infrastructure for their productivity and wellbeing. Poorer infrastructure services in small towns, rural communities and remote areas could lead to limited opportunities for growth and may undermine the long-term viability of some communities.

When this will impact:



Where this will impact:



15. Challenge

Regional infrastructure faces a range of unique challenges and risks, which make it difficult to efficiently provide services that support growth in regional industries. Failure to overcome the challenges and risks facing regional infrastructure raise costs and barriers for investment in regional industries, limiting opportunities for employment and growth, and eroding confidence in the future viability of some areas.

When this will impact:



Where this will impact:



16. Challenge

Infrastructure can do more to support Aboriginal and Torres Strait Islander peoples in remote communities and rural areas, and to underpin progress towards local and national objectives for improving quality of life. Failing to improve services for First Australians in remote communities and rural areas undermines potential improvements in quality of life and reinforces gaps in inequality and disadvantage.

When this will impact:



Where this will impact:



Infrastructure to support regions and unlock growth in northern Australia

17. Challenge

Fluctuations in economic activity in regional industries make it difficult for infrastructure to efficiently and sustainably underpin long-term growth and development. Failure to keep pace with growth can reduce productivity and output during boom years, while underutilised assets raise costs in areas with declining populations, undermining the long-term social and economic viability of regional communities.

When this will impact:



Where this will impact:



18. Opportunity

Infrastructure can help to catalyse growth across northern Australia, and unlock development across a range of industries. Improving the resilience, reliability and efficiency of northern infrastructure could help to capitalise on the immense potential of northern regions, and improve the productivity, quality of life and competitiveness of its people and businesses.

When this will impact:



Where this will impact:



19. Opportunity

Development in northern regions could benefit from more detailed information and evidence-based studies of economic opportunities, as well as a better understanding of local needs and values, particularly of local Aboriginal and Torres Strait Islander peoples. Better information on opportunities and local needs can support more efficient investment and greater benefits for northern communities.

When this will impact:



Where this will impact:



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4

Industry efficiency, capacity and capability

Australia's social and economic infrastructure sectors account for around 21% of national Gross Domestic Product (GDP),¹ and every dollar of value we create is reliant on infrastructure in some way.

Australia's infrastructure needs will continue to grow over time as a result of population and economic growth. Rising demand for new infrastructure services has pushed our infrastructure to be bigger and more complex. While large-scale projects are becoming common place, they are also stretching the capacity of industry and government. At the same time, planning is siloed and poorly integrated, funding options are underdeveloped, projects face procurement issues and network maintenance is often an afterthought.

Australia's infrastructure sector – including the construction and design industries, service providers and operators, financiers, regulators, and policy and decision makers

– is well-established and has delivered high-quality infrastructure to support Australian communities and economic growth. While progress has been made since 2015 in building capacity and improving how we plan, fund and deliver infrastructure, there is still some way to go before best practice is routinely and consistently applied.

We cannot simply build ourselves to future success, and so getting the operation and efficiency of infrastructure services is crucial. Changing customer needs, risks from a global economy, the pressures of climate change and growing community concerns mean that infrastructure projects must meet new standards of sustainability, security and resilience. Incorporating these elements requires new approaches to procurement, building and planning.

This chapter discusses how the sector is responding to changing pressures and demands and how it can meet best practice.



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4.1 Introduction



The state of the industry

By global standards, Australian infrastructure industry capacity and capability is relatively strong, and the efficiency of the sector is high. Australia ranks higher than average for developed countries across a range of measures of infrastructure governance, planning and delivery.²

Each decision to build or upgrade infrastructure can impact on taxpayer and user bills for generations. Every dollar of public infrastructure investment can generate GDP increases that can add up to \$4 of value over the life of the asset.³ It is essential we get these decisions right to improve the quality, affordability and access to our infrastructure.

How we plan, fund and deliver infrastructure has improved since the 2015 Audit, however Australia is not consistently achieving best practice. While both the public and private sectors generally perform well, the sector is characterised by a patchwork of capacity constraints and

outdated regulation and policy. Planning is siloed and poorly integrated, funding options are underdeveloped, projects face procurement issues and network maintenance is often an afterthought. The challenges and opportunities associated with funding sources, using grants and subsidies and funding the maintenance backlog, all impact the quality and access to infrastructure and to the economy as a whole.

Infrastructure projects are increasing in size and complexity, and will require new approaches if they are to be effectively delivered. How the public sector make decisions, handle procurement, select contract models and handle risk will have significant impacts on the functionality and efficiency of our infrastructure. Alongside these changes, new demands for sustainability, resilience and security will provide opportunities to achieve better outcomes. However, this makes the planning and management of industry capacity more complex.



Changes since the 2015 Audit

The 2015 Audit did not specifically examine the efficiency, capacity and capability of the infrastructure sector. However, in light of the scale of investment and construction underway in the sector, it has become clear that it requires close examination. It is important to understand the challenges and opportunities faced in planning, funding and delivering infrastructure, in order to ensure Australia is well positioned for future needs.

Since 2015, Australia's infrastructure sector has increased in complexity and national prominence. There has been an increasing number of mega-projects funded by state and territory governments in response to our rapidly growing population. The private sector plays an important role in delivering and planning these projects, and providing experience and skilled labour. This role will be tested over the course of the next ten to fifteen years. Recently, substantial financial losses on some projects and high volumes of work have caused the market to push back on a range of project risks, particularly on large projects, compounding challenges to market depth. It is vitally important that industry, policy makers and infrastructure workers have the necessary capacity and capability to meet these new challenges.

Since the last Audit, Infrastructure Australia's Reform Series papers have focused heavily on the changing capability needs of the sector. Our analysis and the work of others has resulted in important industry reform. In particular, the increased focus on population policy, improved data collection, scenario modelling and reporting, and the emergence of new governance models for major urban infrastructure have contributed to improved capability within the sector. Despite this progress, and the considerable work from leaders within the industry, there remains room for improvement.

How we plan, fund and deliver infrastructure is evolving

As illustrated in the Future Trends chapter, a range of forces influence how we use infrastructure, and how services are provided. In this context, decisions on infrastructure investments and reforms have had to address a growing set of complex factors, all of which introduce uncertainty to projections about future growth and change.

While uncertainty has grown, so too has the cost of building, maintaining and operating many forms of infrastructure. This raises the stakes for infrastructure investment, and makes robust, evidence-based decision making increasingly important.



Increased risks from changes in the global economy and environment are also increasing the need for infrastructure that is resilient to long-term changes and shocks and extreme events. Embedding these principles in decision-making requires an ongoing effort to identify risks, and develop mitigation strategies that are effective and efficient. Increasingly, infrastructure is going to be called on to meet Australia's international commitments, including finding ways of reducing emissions, helping us to meet our Paris Agreement obligations, and working towards the United Nations Sustainable Development Goals by 2030.

Australia is a leader but best practice is not universal

Infrastructure projects can improve people's quality of life, increase productivity and kick-start economic development. However, to achieve these outcomes, projects need to be carefully assessed, designed and timed. Getting our infrastructure decisions right is crucial to our future success.

There have been substantial improvements to governance, decision making, transparency and collaboration. However, progress is not uniform. Governance and planning have improved, creating greater stability and certainty for investment and innovation. The rigour and quantity of decision making has also improved. The creation of government infrastructure agencies has provided a deeper evidence base, more transparency and enhanced interstate collaboration, which has helped guide governments towards better outcomes for users.

Despite improvements in planning, the project pipeline remains lumpy, which hinders the ability of industry and government to manage workforce capacity and skills effectively. There also remains room for improvement in decision making. Early announcement of infrastructure projects, prior to effective problem identification and robust assessment, narrows choices and excludes the possibility for more efficient and less expensive

solutions. Alongside this, the public service is undergoing a transition, which requires new skills and an increased focus on project management, contracting and procurement.

Funding options are underdeveloped and projects face procurement issues

The selection and execution of a procurement model often overshadows the characteristics and intended purpose of the project itself. This can also result in projects being selected without the long-term cost consequences being well understood. This is not in the best long term interests of users or taxpayers.

Big capital fixes often take undue priority over smaller and more frequent maintenance spends. This is often the by-product of a lack of clear long-term policy objectives across our infrastructure networks. This problem is exacerbated by funding occurring from one-off grants for construction. As a result, planning for the total lifespan of these assets is challenging. Often, users and taxpayers are left to fund the future high costs associated with asset maintenance renewal. Regional areas in particular have trouble funding routine maintenance for roads, bridges and water pipes, causing safety risks, and adding to the cost of using these assets.

Optimising current assets and networks is often a more efficient and cheaper method of meeting future needs than constructing expensive, long-lived assets. However, this option is often overlooked. Governments can use technology to increase efficiency and the operational capacity of networks. There are also a variety of policy solutions that can manage demand, such as providing users with price signals that match supply and demand in a more efficient way. Making correct decisions requires a best practice approach that eliminates bias, increases transparency and optimises project selection.

Mega-projects have become a default, however they are stretching industry and government

The size, scale and complexity of new infrastructure projects is changing. Procurement and planning are correspondingly more complex. Underdone planning and rushed procurement can lead to lasting shortcomings in infrastructure performance. This is compounded by a much needed increased focus on sustainability, security and resilience expectations.

The volume and scale of infrastructure construction, particularly in New South Wales and Victoria, has grown considerably, consuming and in some cases exceeding industry capacity. This has led to reduced competition and ability of governments to achieve value for money outcomes. Alongside this, our infrastructure also faces unprecedented risk from technology, the economy, evolving user preferences

and climate change. These new risks suggest that our approach to resilience, security and sustainability will need to adapt. These need not come at an additional cost to the economy. Planning appropriately for these changes can benefit Australians.

Currently, Australia's infrastructure sector lacks clear, publicly available information on how to manage, construct and plan for greater resilience. Often the whole-of-life benefits associated with managing risks and costs are overlooked, resulting in ineffective designs, specifications and operating procedures.

Consideration of emerging risks will be an increasing challenge for infrastructure policy makers and providers. Assessing risks, such as climate change, can improve resilience while saving costs for users and taxpayers over the asset's life. New approaches to sustainability can also benefit current and future Australians, while providing businesses with expertise and innovation.

In this chapter

4.2 Planning and decision making calls out infrastructure planning and decision making that falls short of consistent best practice, including community engagement, regulation and governance that leaves room for improvement across most sectors.

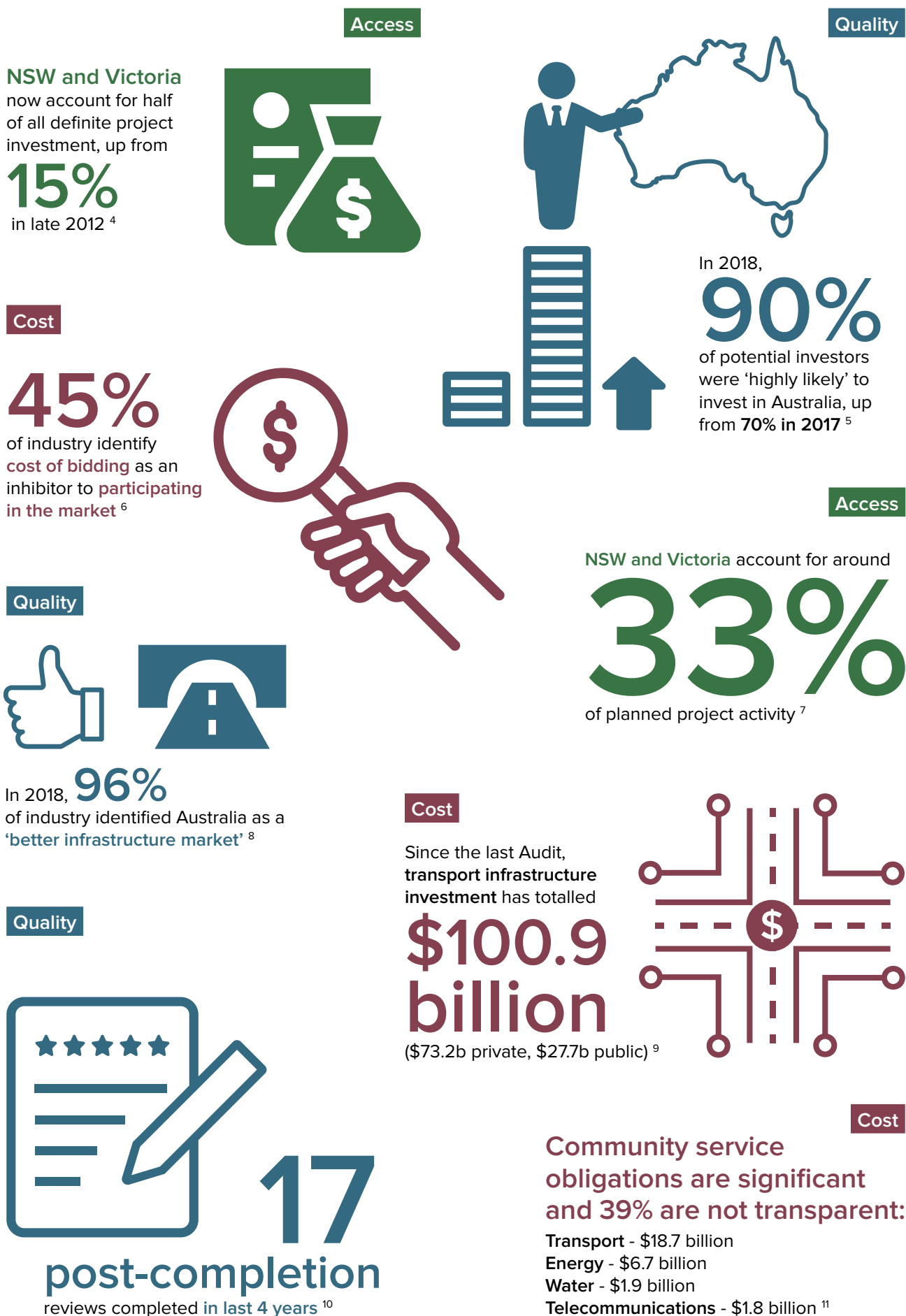
4.3 Funding and financing looks at understanding costs from the perspective of governments, service providers and investors. This finds that there are challenges with Australia's scale and diversity, funding tools are not applied consistently across sectors, and community service obligations (CSOs) play a large role in supporting equitable outcomes, but often lack transparency.

4.4 Market depth and skills highlights improvements in the visibility of the near-term pipeline does not appear to have resulted in better coordination of projects entering the market. The capacity for industry to deliver is limited by the size and nature of projects coming to market, including the risk to sharing arrangements.

4.5 Procurement and contracting identifies outcomes for users are strongest where whole-of-life considerations are acknowledged upfront and are supported by appropriate contract models, and timeframes for procurement and delivery.

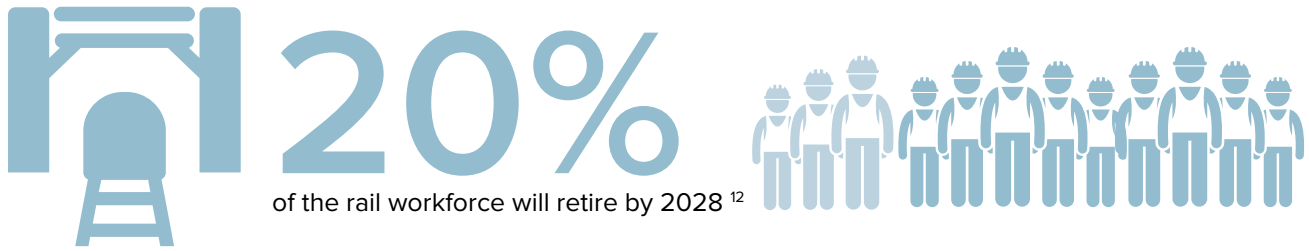
4.6 Security, resilience and sustainability explores the mounting risks for Australian infrastructure from changes in technology, the economy, user preferences and the environment, and calls out many resilience strategies that do not provide adequate guidance. Sustainability of infrastructure will be important to meeting our aspirations and emissions reduction commitments

Performance of the sector



Scale of the sector

Industry



Asset



\$130 billion

of transport infrastructure
projects under construction (2018) ¹³

Customer

\$39 billion

(2.1%) of GDP spent by governments
on infrastructure in 12 months to
December 2018 ¹⁴



Industry

#1 construction

is Australia's **most male dominated** industry ¹⁵

Customer

\$86 billion

spent by private proponents on
infrastructure each year ¹⁶



The national
infrastructure deficit
cannot be measured

Asset

Industry

Over

20%

of GDP attributed to
infrastructure sectors ¹⁷



Customer

Political risk

is the biggest inhibitor
to industry ¹⁸



Asset

Transport, communication, electricity,
gas and water attracted around

\$68 billion

of foreign direct investment in 2018 ¹⁹



4.2 Planning and decision making

At a glance

Getting infrastructure decisions right is vital for our success. But while governance and planning have improved in some ways, we still fall short of consistent best practice:

- Inadequate community engagement means our plans do not reflect user needs.
- Inconsistent governance frustrates users and will likely lead to higher costs.
- Future trends will require new or modified regulation to avoid risks and capitalise on change.

Getting infrastructure decisions right is vital for our success

Australians expect their leaders to make robust, transparent and accountable decisions on infrastructure. We expect limited public funds to be spent prudently, markets to provide services that match user needs at affordable prices, and bring improvements in quality of life and productivity.

Public infrastructure is an important catalyst for economic growth and development.²⁰ Economy-wide estimates suggest that every dollar of public infrastructure investment can generate GDP increases that can add up to \$4 of value over the life of the asset.²¹ But for infrastructure to play this role, projects need to be rigorously assessed, carefully designed and appropriately timed.²² The outcomes of infrastructure reforms or investment depend on the quality of planning and decision making.

Governance and planning have improved in some ways

By global standards, Australia's infrastructure governance is relatively strong. Our institutions and regulatory systems are well established, and have performed reasonably well by ensuring affordable and efficient services for users. We have a stable and attractive environment to operate, invest and innovate in infrastructure, and we provide greater certainty to investors, operators and users than in many other countries. Australia ranks higher than average for developed countries across a range of measures of infrastructure governance, planning and delivery.²³

Since the last Audit, there have been significant steps across the Australian Government and state and territory governments to improve project planning and selection. The proportion of projects for which business cases have been undertaken has increased, and the rigour of most of these business cases has improved over recent years. Also, most state and territory governments and a number of local governments have published long-term infrastructure plans. These include Infrastructure Victoria's *30-year Infrastructure Strategy*,²⁴ and the third iteration of *The*

State Infrastructure Strategy from Infrastructure New South Wales.²⁵

Governments in most states and territories have created infrastructure agencies to provide guidance to their respective governments on transparency in planning and governance, and to support greater collaboration on similar challenges and opportunities within and across state borders. While detailed functions vary, the agencies have all been established to improve the rigour of infrastructure decision making. These agencies include:

- Infrastructure New South Wales (2011)
- Infrastructure Victoria (2015)
- Infrastructure Tasmania (2015)
- Building Queensland (2015)
- Infrastructure South Australia (2018)
- Infrastructure Western Australia (2019).

There remains substantial room for improvement in decision making

Despite the relative strengths of our infrastructure governance, not every infrastructure intervention is as effective as it could be. Projects have been announced without a detailed assessment of needs and an analysis of the range of potential solutions being undertaken. Where they are undertaken, business cases are not always published to allow for public consultation and scrutiny. Post-completion reviews are rarely undertaken, providing limited insight as to whether intended benefits have been realised.

Failure to get infrastructure governance right has eroded some public support for broader large-scale investment programs. Reserve Bank Governor Philip Lowe highlighted this point in reference to issues with delivery of the Sydney Light Rail project as an example.²⁶ However, these issues are by no means isolated to transport. There have been ongoing governance challenges across all sectors, with clear examples over recent years in the National Electricity Market, the Murray-Darling Basin and the National Broadband Network.

Across many parts of the country, decision making is falling short of best practice. Best practice was identified by Infrastructure Australia in the *Infrastructure Decision-making Principles*, published in June 2018. This document laid out clear expectations for nationally significant, publicly funded projects across the project lifecycle – from problem identification to post-completion review.²⁷

However, of the 39 projects that have been assessed by Infrastructure Australia over the past three and a half years, none has met all 11 principles (Figure 1). There are five broad issues in project decision-making that require improvement:

- Transparency of decisions across all stages of the project lifecycle, including public release of business cases and analysis underpinning planning processes.
- Consideration of all options for solving a problem identified through long-term plans, including potential solutions that make better use of existing infrastructure.
- Rigorous analysis of potential solutions through completion of a business case before commitment to a project, including consideration of future risks to demand and supply.
- Engagement with communities on potential solutions in project development to integrate feedback in decisions on options assessment, project design or delivery.
- Preparation and publishing of post-completion reviews for projects to ensure that expected benefits were realised, and lessons learnt through planning and delivery can be applied to future decisions. As illustrated in Figure 2, there is a dearth of published post-completion reviews and little evidence of sharing of lessons of experience.

Lessons from the nbn

Rigorous analysis and engagement prior to implementation provide checks and balances to ensure risks are identified early, and the final decision is the right one. The clearest illustration of the importance of these processes is provided by the National Broadband Network (nbn), Australia's largest public infrastructure investment since the Snowy Mountains Scheme. Ten years on from the establishment of nbn in 2009, this project provides clear lessons for future infrastructure decision making.

An implementation study for the nbn was commissioned and released in 2010. It found that the nbn would have a strong business case, generate returns to cover borrowing costs and be constructed for less than the \$43 billion that had been budgeted (in 2009 dollars).²⁸ A full cost benefit analysis (CBA) for the nbn was not commissioned by the government. Consequently, options for delivery were not transparently assessed according to their relative net benefits, and a number of risks and challenges were not addressed before rollout commenced.

The scope of the nbn has changed substantially during its rollout. Each of these stages presented a further opportunity to ensure appropriate decisions were being reached through the development of a business case, including a CBA. Similarly, other major projects that experience significant changes in scope, such as WestConnex in Sydney, have also not undergone updates to their business case following scope changes.

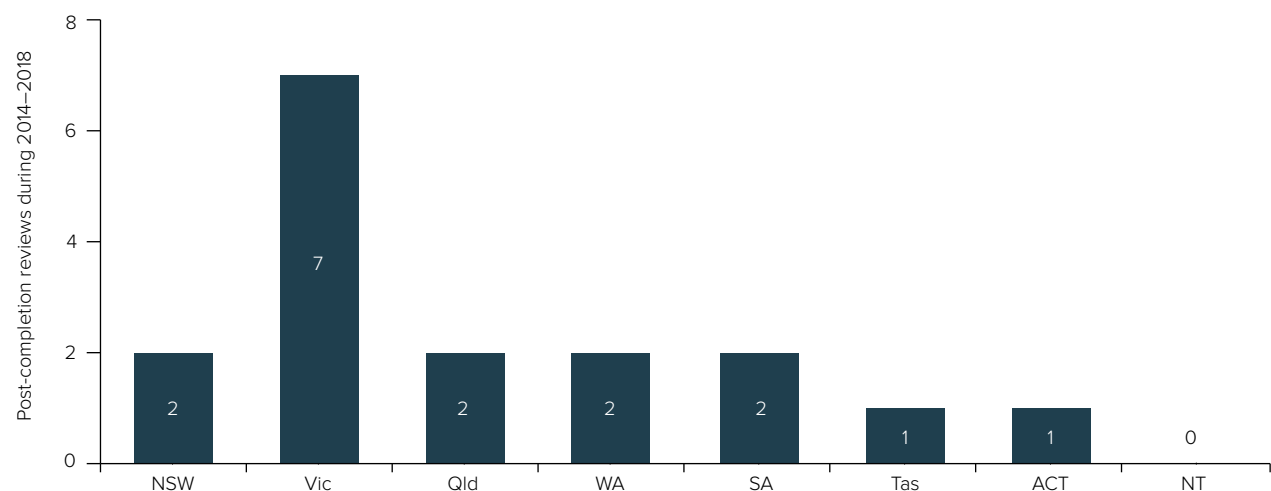
Notwithstanding the desirability of new business cases, it is likely that a well-considered business case could have helped to avoid changes to scope and mitigate issues that have subsequently emerged. A more comprehensive assessment and transparent disclosure of all decision making on this project during the planning and development phase would have likely reduced delivery costs and time. This process may have helped to establish broader agreement within governments and industry on the project's scope, reforms required to facilitate rollout, and how risks should be managed.

Figure 1: Infrastructure Australia's *Infrastructure Decision-making Principles*



Source: Infrastructure Australia (2018)²⁹

Figure 2: Few post-completion reviews have been undertaken since the last Audit



Source: Grattan Institute (2018)³⁰

20. Challenge

Decision-making processes across many jurisdictions and sectors are not meeting best practice standards, including application of the *Infrastructure Decision-making Principles*. Failure to improve project decision making is likely to reduce the potential productivity and quality of life improvements of infrastructure investments.

When this
will impact:

0-5

5-10

10-15

15+

Where this
will impact:



Project selection does not always align with quality of life objectives

The creation of independent infrastructure bodies, such as Infrastructure Australia, has helped to lift the quality of project selection by governments, improve investment efficiency, increase the effectiveness of solutions, and ensure investments support the health of the economy.

The key tool used in Australia, including by independent infrastructure agencies, to support the assessment and selection of infrastructure projects is cost benefit analysis (CBA). It aims to 'identify and express, in monetary terms, all the gains and losses (benefits and costs) created by an initiative to all members of society and to combine the gains and losses into a single measure of net benefit (benefits minus costs)'.³¹ A benefit-cost ratio (BCR) greater than 1.0 indicates that the benefits of the project outweigh the costs.

CBA is particularly useful in circumstances where:

- a clear objective is identified
- problems can be clearly defined and quantified over the life of the asset (or have satisfactory substitutes or proxies)
- solution identification has begun³²
- economic efficiency and wealth creation is a central goal
- there are large populations and more developed economies.³³

CBA has its origins in the United States in 1936 as a tool for assessing transport projects. It has subsequently become the benchmark standard for comparing alternative solutions to a public policy need in major project selection processes both domestically and overseas. The methodology has also been adopted by the World Bank, the Asian Development Bank and the European Commission.³⁴

CBA provides the community with a transparent mechanism to assess investment decisions.

This analysis-driven approach is a substantial improvement from past processes which drew primarily on the industry knowledge of a select few, or worse, were based on uninformed estimates or political whims. The increasingly widespread adoption of CBA and improvements in business case development, particularly where they are published in advance of decisions being made, has helped to ensure finite taxpayer dollars are spent more wisely.

A strength of CBA is its 'evaluative standpoint', the implied ability to effectively undertake a single assessment on behalf of a collective, or group of individuals.³⁵ To that end, CBA is a robust and insightful input to support decision making, allowing the comparability of projects by the community, particularly regarding economic efficiency and wealth creation.³⁶ It is particularly useful as a relative benchmarking tool, when comparing different solutions to a given problem or opportunity that share the same assumptions.

CBA is an important tool for assessing the economic, social and environmental merit of infrastructure projects. However, it is not adequate to be the sole determinant of a decision to invest. Rather, it is a tool that supports decision making.

Some social outcomes, such as those related to quality of life, are more intangible and difficult to quantify in CBA. These outcomes may therefore only receive consideration at the qualitative level in business cases. Projects focused on such outcomes could then be placed at a comparative disadvantage to other projects when competing for scarce funding resources.



Infrastructure Australia's consultation with local, state and territory jurisdictions has identified opportunities to enhance infrastructure decision making in Australia, many of which have also been identified by industry and academic research. Decision making can be strengthened by better assessing:

- alignment between stated assessment outcomes and *truly* desired community policy outcomes³⁷
- project contributions to broader social outcomes, such as addressing poverty or entrenched disadvantage³⁸
- indirect, long-term benefits that infrastructure services can unlock³⁹
- pioneering development, research and innovative or new industries⁴⁰
- project investments that front-run growth or provide additional capacity⁴¹
- aesthetic characteristics⁴²
- the impacts of changing inputs, such as population projections, and methodologies.⁴³

These opportunities are largely related to considering the indirect, long-term benefits that infrastructure services can unlock.⁴⁴ Despite their importance and significance to infrastructure, the assessment of these impacts can be difficult to effectively assess and definitively ascribe to an infrastructure investment using traditional models.⁴⁵

At the same time, the quality of the use and application of CBA in Australia is subject to the skills and knowledge of the individuals using the tool. The potential for under-estimation of costs and the over-estimation of benefits, so-called optimism bias, has become a risk to the appropriate use of CBA, as noted by the Productivity Commission,⁴⁶ and by international jurisdictions including the UK.⁴⁷ The potential for these factors to inflate a BCR and net present value undermines good decision making.

However, importantly, the application of CBA is also not static. CBA is an evolving process that can be improved over time with more rigorous application, more robust inputs and a wider consideration of impacts.⁴⁸ As policy priorities are more specific and measurable, allowing better consideration of intended project outcomes and broader policy context, and additional data becomes available to support assessment, there will be considerable opportunity to build upon the existing strengths of CBA.

The Infrastructure Australia *Assessment Framework* requires proponents to present consideration of the strategic merit of projects and an assessment of their deliverability.⁴⁹ The alignment between the strategic merit of projects and the findings of CBA has improved, strengthening the tool and decision making. Consideration of the policy goals and strategic context for a proposed project can ensure project decisions are better founded and justified.⁵⁰

Evolving the application of CBA to give greater regard for intangible benefits could meet some current gaps. For example, in the UK, Social CBA and Social Cost-Effectiveness Analysis are used to evaluate the social welfare impacts of different investment options.⁵¹ The use of other tools may also be necessary to supplement CBA and ensure the full range of infrastructure objectives can be fulfilled.⁵² The consideration of wider economic benefits and other tools, such as multi-criteria analysis, could compliment traditional use of CBA, particularly during options assessment. However, these tools themselves have known limitations.⁵³ No single tool is an adequate replacement for CBA, however an increased strategic view of the role of projects in progressing national objectives is vital within business cases.⁵⁴

Community engagement in decision making is inadequate

Government and operator engagement with customers and the broader community on project and operation decisions, is lacking across most sectors and jurisdictions. This issue was highlighted in the previous Audit and Infrastructure Australia's *Infrastructure Decision-making Principles*.⁵⁵

Meaningful engagement on infrastructure decisions requires that service providers talk with people and businesses directly impacted by decisions. It also requires governments to consult on policies and plans with the wider community. In a broader context, governments have a role to engage and seek feedback on the scale and pace of change and how individual changes will impact their broader town, suburb, city or region, and whether this reflects the community's vision of the future.

However, engagement on projects is often limited to the requirements specified by planning agencies. Policy enquiries or reviews are often limited to seeking submissions in response to a draft report. Unsurprisingly, the number of submissions is often small, and the submissions are usually from individuals or organisations with a deep interest in the particular policy question. Wider public or user opinion is rarely tapped into, and the views of the majority are often subsequently unknown.

Engagement with communities and businesses can also help to establish a social licence for projects by providing a means of hearing from stakeholders and incorporating their feedback through project planning and delivery. A failure to engage can carry substantial costs to projects. For example, it is estimated that around \$20 billion worth of infrastructure projects was delayed, cancelled or mothballed due to community opposition over the past decade.⁵⁶

As identified in *Planning Liveable Cities*, in many cases, community engagement is occurring too late in the process to influence decisions, if it occurs at all.⁵⁷ In particular, engagement tends to focus on projects, not strategic land-use plans. As a result, the decision to proceed may have been made long before consultation occurs.

Access to more data on current or potential users may enable more rigorous analysis of future demand. However, better data does not replace the need for engagement. Rather, enhancements in information on users should enable governments and industry to engage more deeply with the most relevant stakeholders. Over time, this may make it easier to ask the right people the right questions to develop a targeted approach to delivering infrastructure, and to explain the sometimes difficult policy and spending trade-offs that are inevitable in infrastructure decisions.

21. Challenge

Many decisions are being made without meaningful engagement, and without the means for comment and stakeholder feedback to inform project planning and delivery. By not adequately engaging, governments and proponents miss the opportunity to address stakeholders' concerns, ensure projects and reforms meet their needs, establish social licence and build trust in decisions.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Regulation and governance of Australia's infrastructure is a patchwork

Appropriate regulation, robust governance arrangements, and sound decision making all play a crucial role in securing productivity improvements, lowering costs and increasing the quality of infrastructure services.

However, the role, function, ownership and objectives of our infrastructure markets vary greatly. This means that the appropriate role of policy makers and regulators also varies across each sector. Regulatory sophistication also differs across jurisdictions and sectors. Much of this variation is due to market developments since the 1980s and 1990s, when some sectors were deregulated and government businesses were corporatised.

Reporting against outcomes that are valued by users has been lacking in some sectors. Even when services are performing relatively well, this lack of

clarity can undermine community confidence in service delivery or oversight, and relatively minor incidents can cause community frustration around perceptions of inflated prices or declining service quality. Infrastructure Australia has previously provided detailed analysis of these issues in urban water,⁵⁹ but similar problems exist in other infrastructure sectors.

While some regulators publish objectives that relate to users' interests, many users believe that decisions fail to reflect what they want, and their capacity and willingness to pay. In the energy sector, for example, a perceived disconnection between users' interests and the actions of industry and regulators has caused growing frustration.⁶⁰ Similarly, the complexity of pricing arrangements has discouraged some customers from actively managing their bills, leading to higher costs for loyal customers.⁶¹ Consequently, only a third of energy consumers believe the market is working in their interests.⁶²

Regulatory complexity poses challenges for community understanding

Regulation and oversight in the electricity sector is exceptionally complex, with at least half a dozen separate bodies and agencies bearing responsibility for the wholesale, network, retail and other aspects of the sector. While our national system of regulation is among the world's most sophisticated, this has introduced substantial complexity that makes it difficult for users to understand why their bills have risen, or whether reliability has deteriorated.

In telecommunications, although the ACCC has recently undertaken a number of enforcement actions and other initiatives in relation to broadband speeds and mobile coverage,⁵⁸ a perceived lack of oversight has led to many users feeling that they are not receiving the service they were promised by retailers. Some perceptions of declining performance and rising costs have not always reflected reality.

In contrast, roads are inconsistently regulated. The construction, operation and maintenance of roads are almost exclusively undertaken by or for different levels of government. As a result, service quality differs greatly by region and by type of road. The link between what users pay and the costs they incur and impose on other road users is weak and, as in other sectors, transport-related CSOs across the country are opaque.

22. Challenge

Across many infrastructure markets, regulatory principles are complex, inconsistent, do not sufficiently protect the long-term interests of users, and reporting does not always align with user outcomes. A lack of clarity on user-focused objectives is likely to lead to worse outcomes for many users, and frustration with the perceived complexity of markets and decision making.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:





Increased complexity and uncertainty will require a change in oversight

In the past, infrastructure sectors tended to be more clearly delineated than they are today, with separate networks, markets and rules. However, the increase of complex, interconnected trends will require greater coordination between individual infrastructure sectors in order to achieve positive outcomes. The links between sectors are likely to grow in scale and complexity. For example:

- Road networks are increasingly dependent on telecommunications for navigation and safety, and this trend will accelerate with the advent of connected and automated vehicles and 5G technology over the coming years.
- The relationship between transport and energy will become more complex as uptake of electric vehicles increases. Various governments, including New South Wales,⁶³ and Victoria,⁶⁴ have identified this trend and set out a framework for managing this transformation.

- Prevention of chronic disease will not be solely undertaken within the health sector. It will be reliant on access to green, blue and recreational infrastructure as well as active transport facilities that enable healthy lifestyle choices.
- Water is becoming increasingly reliant on telecommunications and remote energy technologies for monitoring, improving efficiency and connecting directly with users.
- Social infrastructure services – particularly in health, education and justice – are increasingly leveraging developments in telecommunications to improve service efficiency and quality – particularly by avoiding the need for physical proximity and travel.

These changes provide a challenge to regulators and policy makers, to ensure they adequately mitigate risks and capitalise on rewards of change, as well as ensuring decisions taken today are resilient to a range of future scenarios.

23. Challenge

How infrastructure is provided and used will transform over coming decades, meaning laws and regulations will need to be reviewed, removed or updated. Failing to anticipate and adapt to change will undermine Australia's global competitiveness, stifle innovation and reduce the benefits of productivity-enhancing technologies.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



4.3 Funding and financing

At a glance

Australia's size and varied population density create funding challenges. There are clear signs of the need for increased capital and maintenance investment across many sectors, however it is impossible to quantify a national infrastructure funding gap.

This section discusses:

- different needs between jurisdictions, and how funding methods vary by sector and region
- growing budget pressure from grants and subsidies
- a lack of transparency and effectiveness in community service obligations
- risks from ageing assets and underinvestment in maintenance
- opportunities in optimising our existing networks and using funds more efficiently.

There is an infrastructure funding deficit, but it cannot be measured

Australia's scale and geography have contributed to perceptions of an infrastructure funding deficit. Rising congestion, electricity blackouts, mobile blackspots and water shortages – among many other infrastructure problems – are often quoted as evidence of past failures to invest in the right infrastructure of a sufficient scale. This funding shortfall has previously been acknowledged by Infrastructure Australia, particularly in regard to maintenance funding.⁶⁵

However, it is not possible to meaningfully and comprehensively quantify the infrastructure funding gap. Unless all options to all problems and a range of potential solutions have been considered through comprehensive cost-benefit assessments, to ensure the most efficient solutions are selected, including potential non-capital solutions, it is impossible to quantify a total deficit. Also, this analysis would soon be obsolete, as problems evolve, demand projections change and new options become available. Any estimate of a 'funding gap' is only a snapshot at a point of time.

No single figure can capture the intricacies of the various outcomes delivered by all classes of infrastructure. In place of a single figure, a more informed discussion would better reflect measures of infrastructure outcomes for users. Within this Audit we have sought to consider the deficit both in terms of the assets themselves, but also through considered user perceptions of the services they received. Other

measures that provide useful insights to infrastructure services could include assessments of the quality of the assets we have, such as through:

- achievement of performance standards
- the proportion of Australians with access to infrastructure services
- levels of investment in renewing and maintaining assets.

We know that more money is required – problems can rarely be fixed for nothing. Infrastructure Australia has previously called for additional funding for infrastructure – particularly for solutions that make better use of existing infrastructure, in Recommendations 1.5 and 1.7 of the 2016 *Australian Infrastructure Plan*.⁶⁶

More funding for the right projects, at the right time, would help to close the gap between what we have and what we need. The *Infrastructure Priority List* provides a list of projects which have been assessed as productivity-enhancing solutions to nationally significant problems.⁶⁷

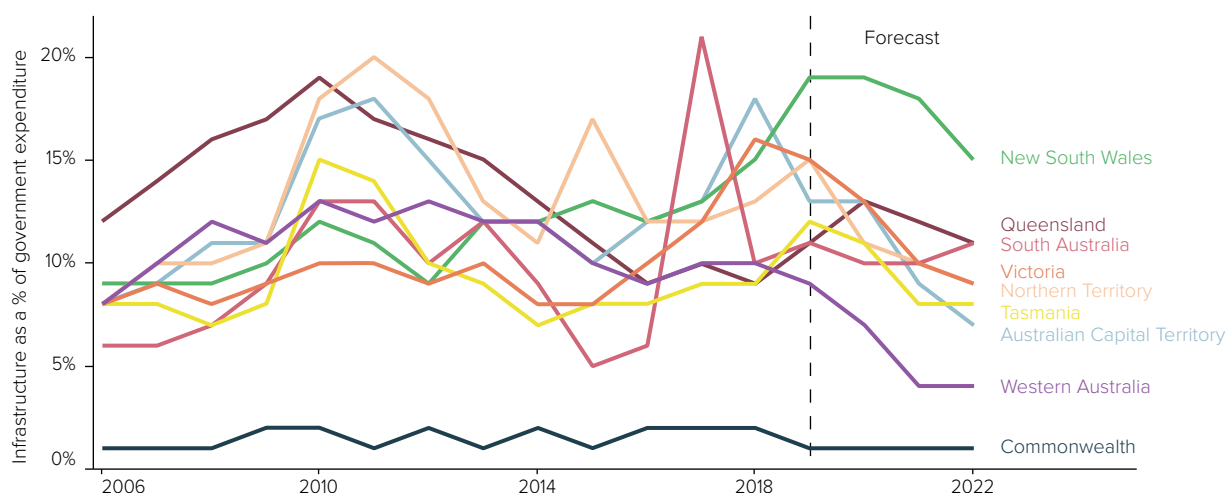
Funding for infrastructure varies greatly between jurisdictions

Around \$39 billion of engineering construction work was done for governments of all levels in the 12 months to December 2018.⁶⁸ This represents 2.1% of GDP.⁶⁹ Australia invests heavily in transport, particularly roads, compared to other OECD nations, however, we rank below the long-term OECD average for total infrastructure investment as a proportion of GDP.⁷⁰ Australia's investment levels are also below the 2.5% of annual GDP forecast by the OECD to be required to 2030.⁷¹ The current levels of infrastructure investment by some governments is perceived as elevated, however the levels of investment from our OECD trading partners will mean further investment in our infrastructure will be required to maintain our quality of life and productivity over the longer term.

A further \$58 billion was spent by private proponents on infrastructure each year,⁷² though much of this is concentrated in the mining and resources sector. In 2016-17, governments also spent \$125 billion on health, and \$94 billion on education.⁷³

Among Australia's states and territories, funding levels vary considerably (Figure 3). New South Wales and Victoria now account for half of all definitive project investment, up from 12% in 2012.⁷⁴ They additionally are forecast to account for around one-third of planned future project activity. Jurisdictions with vast areas and dispersed populations – Queensland, Western Australia, South Australia and the Northern Territory in particular – face considerable pressures to fund equitable services, being home to some of Australia's most isolated and most disadvantaged communities.

Figure 3: Australian governments vary in terms of proportion of expenditure spent on infrastructure



Source: Infrastructure Partnerships Australia (2019)⁷⁵

24. Challenge

Funding for public infrastructure has risen above historical trends, but remains below that of many other nations and may need to rise further to maintain or improve user outcomes. Without sufficient funding for public infrastructure, outcomes for users will deteriorate over time, undermining productivity and quality of life.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



User pays remains underutilised as a funding source

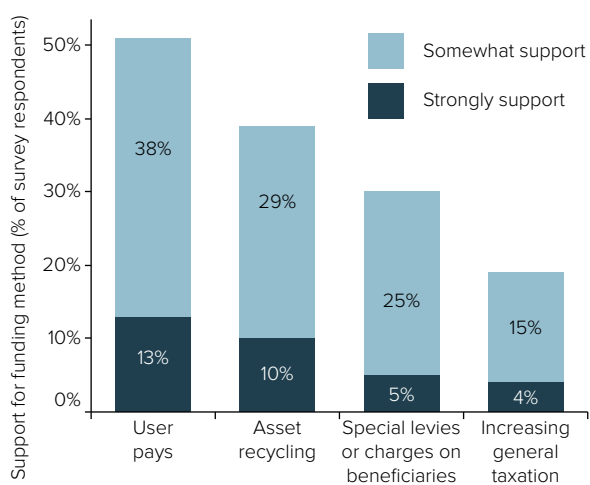
In general, recovering costs from those who use or directly benefit from services is an efficient, equitable and sustainable funding method. User pays fees and charges range across most sectors from public transport to water and electricity, and in social infrastructure sectors from gallery visitation, court fees and some health care.

User pays arrangements have a long history in Australia, dating back to the very first toll road built in Sydney in 1811, and to the Sydney Harbour Bridge in 1932.⁷⁶ Today, user pays arrangements are the only model that receive support from a majority (51%) of Australians as a means of increasing funding for infrastructure development (Figure 4).⁷⁷

Despite this, the degree to which user fees cover the full costs of infrastructure services vary greatly. For example, in 2013, the estimated cost recovery for public transport services in Australian cities ranged from 22% in Sydney to 30% in Perth. This is well below comparative cities, such as 44% for Auckland and 73% for Toronto.⁷⁸ However individual routes can deliver commercial returns, including the Manly fast ferry service in Sydney, which operates at full cost recovery.

In some sectors, the amount that would be acceptable to charge users does not cover the full cost of delivering, operating and/or maintaining the required level of infrastructure and services. As a result, the broader taxpayer base must contribute to these costs via government funding. This is evident in the provision of most roads, rail and smaller ports. Consequently, user pays arrangements are most commonly used as part of a mixed funding model.

Figure 4: User pays is the most popular way of increasing infrastructure funding



Source: JWS Research (2018)⁷⁹

Infrastructure services are often reliant on ongoing subsidies

Community service obligations (CSOs) exist to support services that are provided for a social purpose that are non-commercial or would need to be provided at a higher cost in order to be commercial.

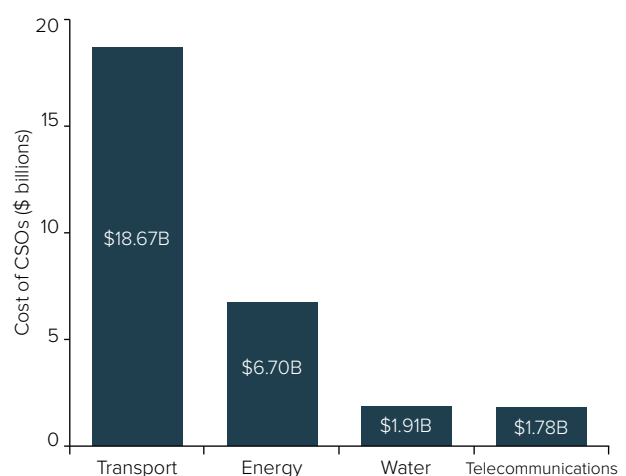
Within some areas of infrastructure service delivery across Australia, and in most infrastructure sectors in small towns, rural communities and remote areas, these subsidies are vital to the provision of infrastructure that supports quality of life and addresses social disadvantage.

Research conducted for Infrastructure Australia identified there are over 300 CSOs in transport, energy, telecommunications and water across Australia, with a total annual cost of approximately \$29 billion, or 1.7% of GDP (Figure 5).⁸⁰ This does not account for CSOs in social infrastructure.

Within those sectors that were examined, definitional ambiguity, similar in nature to the concerns identified by the Productivity Commission (formerly the Steering committee on National Performance Monitoring of Government Trading Enterprises) in 1994,⁸¹ presents challenges to accurately identify, and reflect the scale of CSOs and compare between sectors.⁸²

Of these CSOs, we have identified that 78% are indirect subsidies – their purpose is to provide services at a higher quality or a lower cost than would be commercially viable. Some 39% of CSOs in Australia are not transparent. This varies across jurisdictions – from the 20% that lack transparency in Queensland, to the 75% of unclear CSOs in the Northern Territory.

Figure 5: Community Service Obligations play a major role in funding infrastructure across the country



Source: Centre for International Economics (2018)⁸³

CSOs play a particularly dominant role in transport funding. Almost half of Australia's infrastructure CSOs are in the transport sector, and these account for 64% of the total annual CSOs cost – or \$18.7 billion each year. Roads are almost entirely funded by taxpayers – with the exception of toll roads, which represent only 248.4 km – or 0.0003% – of Australia's road network.⁸⁴ Some state and territory jurisdictions also hypothecate vehicle registration to road expenditure. Public transport is also heavily subsidised by taxpayers, on average 70% to 80% in our fast-growing cities and more than 90% in smaller cities and regional centres.⁸⁵

Across other sectors, the proportion of services funded by taxpayers rather than users is lower, but the scale of CSOs remains extensive:

- In telecommunications, for example, there are 18 CSOs, with a total value of \$1.8 billion (6% of all CSOs).
- In energy, there are 91 CSOs with a collective value of \$6.7 billion. These are primarily to provide discounts, concessions and rebates for households and businesses, to provide uniform prices, to address peak demand, or to allow for cross-subsidisation for regional and remote areas.
- In the water sector, there are 54 CSOs with a total value of \$1.9 billion. Of these, over 60% of the value is to subsidise revenue gaps for remote services or to deliver remote and Aboriginal and Torres Strait Islander policy objectives. The National Water Initiative has driven greater efficiency in funding arrangements and has led to greater transparency with 69% of CSOs categorised as transparent.⁸⁶

The nature of CSOs is likely to come under increasing scrutiny as improvements in data and technology allow more accurate understanding of their efficacy.

Transparency around the role and nature of these subsidies will be essential to allowing monitoring of their performance and potential tailoring to better meet the needs of users.

While some existing CSOs are longstanding, notably in the provision of transport services using long-established routes and networks or the provision of technology specific telecommunications services, the needs and preferences of consumers are shifting rapidly potentially leaving expensive CSOs outdated and undervalued.

Pressure on government budgets is likely to be compounded by rising CSO costs. Over the four-year budget cycle, CSOs are projected to rise by \$3.6 billion, or around 12%.⁸⁷ This is largely driven by the transport sector, where outdated services, continued network expansion, under-recovery of operating costs, ongoing population growth and an increasing proportion of users who are eligible for concessions is expected to lead to further growth in the cost of taxpayer-funded obligations.

The potential for a growing gap can be compounded by a set and forget approach to services. For example, root-and-branch reviews of public transport networks are infrequent, and have not taken place in most Australian cities and regional centres for decades. The slow pace of review is resulting in highly subsidised bus services, which are relatively simple to review and reassign, continuing to follow the routes of long-removed tram services, first laid out more than 100 years ago and removed during the 1950s and 1960s.

The energy sector could also be a source of increasing CSO costs, especially if energy prices continue to rise, causing a rising cost of concessions and rebates funded by taxpayers.⁸⁸

25. Challenge

Many community service obligations lack transparency, are not frequently reviewed, and may be inefficient. Opaque funding arrangements erode community support for CSOs and the benefits they deliver, while the lack of consistent review processes means taxpayers cannot be sure that this funding is efficient and delivers value for money.

When this will impact:

0-5

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10-15

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Where this will impact:





Ageing assets represent a long-term funding and performance risk

There is little doubt that a maintenance backlog exists across many parts of our infrastructure networks, although the extent varies by sector and region. Some of the maintenance backlog is evident to users of many roads and bridges that suffer from poor upkeep, particularly in regional areas, causing safety risks, reliability issues and adding to vehicle costs.

The causes of the maintenance backlog are diverse. In some cases, the absence of cost recovery arrangements means that there is no mechanism linking usage (which drives the physical depreciation of assets and the need for maintenance) with a direct funding source to undertake repairs. In other cases, the backlog has been caused by governments prioritising the construction of new assets, or failing to undertake preventative maintenance – leading to higher costs for reactive maintenance.

Australian Government or state and territory government funding is often provided as a one-off grant for construction, without provision of additional funding for ongoing maintenance and operational costs. As such, capital grant programs can increase the value of asset bases without committing forward funding certainty, and can exacerbate existing maintenance backlogs and decrease the value of the original investment.

Funding for infrastructure is also typically provided within forward budgetary cycles of four years, making it difficult to plan for the future of assets that have much longer economically useful lives. A lack of certainty of funding beyond the budgetary period can introduce incentives to ‘patch-up’ problems, rather than apply more efficient long-term solutions. This is compounded by a lack of transparency in reporting of asset and network condition, maintenance and performance.

26. Challenge

A historical underspend on preventative maintenance, short budgetary and funding cycles, a lack of data and incentives, and inadequate reporting have contributed to a maintenance funding backlog across infrastructure sectors. An ongoing maintenance backlog will erode quality and reliability of many assets, and bring higher costs for future asset maintenance and renewal.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Optimising existing networks can help meet future needs

While the Australian economy and our population are growing relatively rapidly, it is often not affordable or practical to fund new projects, especially in urban areas where space is already limited. Physical constraints, particularly within urban areas, inhibit the provision of additional capacity to many assets. For example, the space provided to cars, public transport, active transport and street furniture must be balanced kerb to kerb on any street.

Governments will need to make better use of existing assets rather than simply funding additional supply. Some options include using technology to increase the efficiency and operational capacity of networks or to more efficiently manage demand, or using price signals to match existing supply with demand in the most efficient way.

Since the last Audit, the consideration of smarter applications of technology has been applied to major transport infrastructure enhancements across our fast-growing cities. Within Sydney, for example, the planned introduction of metro rail has increased the capacity of the existing railway lines, such as Epping to Chatswood Railway, while smart motorway technology has increased the capacity of the M4 corridor as a component of the WestConnex project

A similar approach has been applied to motorway upgrades in Perth, Adelaide, Canberra, Brisbane and Melbourne as part of a wider move to increased use of non-build enhancements within major capital investments. Despite the increased focus on major projects, there remains substantial scope for additional improvements through better use of existing assets in our smaller cities and regional centres.

There is no evidence of a shortfall in finance for infrastructure

Much of the strength of Australia's infrastructure today is its attractiveness to private investors, who complement the role played by government. Australian infrastructure has proven itself to be among the most stable and attractive asset classes for private capital over a long period. Australia's infrastructure finance markets are among the world's most sophisticated and attractive.⁸⁹

The stock of Australia's inward foreign direct investment has nearly doubled over the last decade, from \$444 billion in 2007 to \$849 billion in 2017.⁹⁰ Australia has a well-developed, strongly regulated system of debt and equity markets and a robust set of policy frameworks, supported by private property rights and the rule of law. In 2017, Australia attracted the 13th largest amount of inward Foreign Direct Investment (FDI) in the world.⁹¹ Transport, communication, electricity, gas and water attracted around \$50 billion of FDI in 2017, while a further \$500 million of FDI was in industries that rely on infrastructure.⁹²

Approximately 96% of participants in Infrastructure Partnerships Australia's 2018 investor survey view Australia as one of the better markets for infrastructure business, including half who consider Australia a clear leader. Participants in this survey collectively own or manage around \$380 billion of infrastructure assets around the world.⁹³

There is little evidence that financing constraints are acting as an obstacle to the provision of productive infrastructure across the country. Conversely, 90% of potential investors are 'highly likely' to invest in Australia, up from 70% in 2017.⁹⁴ Competition to operate infrastructure services is also high, with significant growth in interest from overseas operators over recent decades across all sectors.

27. Opportunity

Low- or non-capital better-use solutions to infrastructure problems could help to avoid or delay investment in expensive new or upgraded assets. These solutions could stretch public funding for infrastructure further, bringing productivity benefits for more users sooner.

When this will impact:



Where this will impact:



4.4 Market depth and skills

At a glance

The project pipeline is large, deep and visible, but this has not led to better coordination of projects entering the market. Subsequently, an overheated market is leading to competition challenges and risk aversion in project delivery. Governments are increasingly turning to international contractors, but their unfamiliarity with the local market can cause problems, with opportunities remaining for better engagement of tier 2 and 3 contractors.

This section finds challenges in:

- encouraging competition to support user outcomes
- managing Australia's skills pipeline, including for the public sector
- addressing the construction industry's entrenched culture and gender inequity.

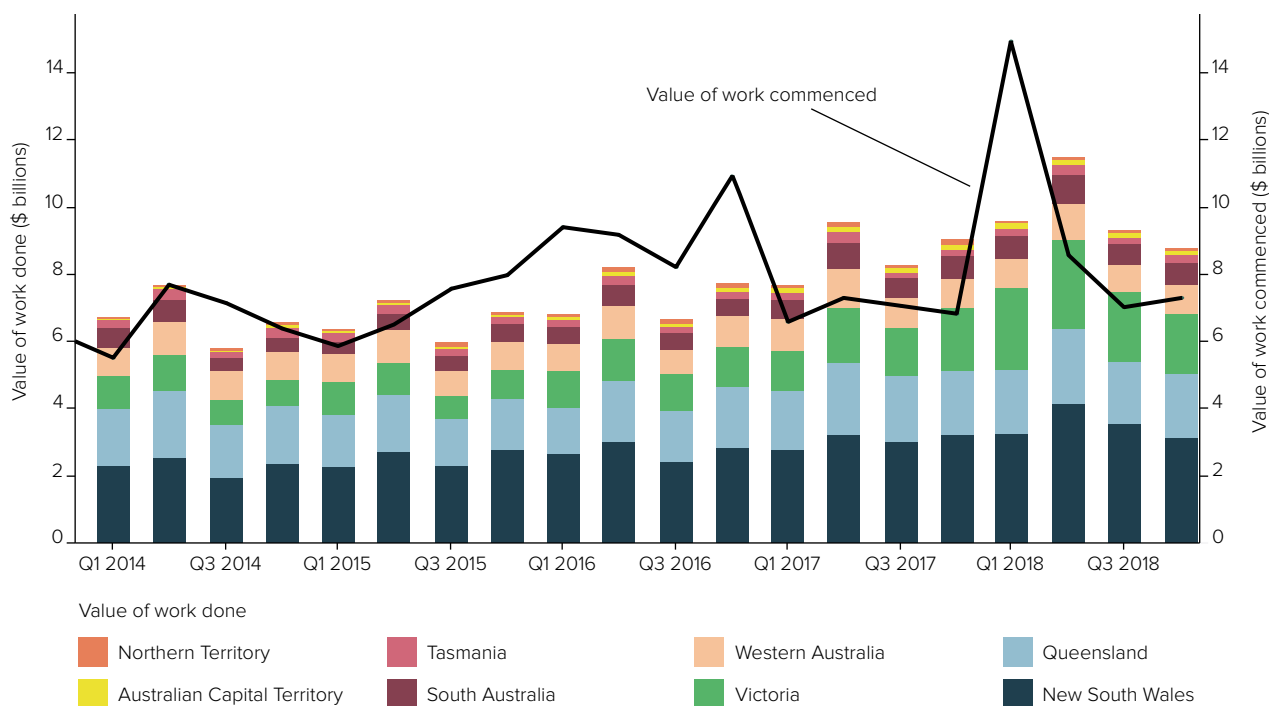
The project pipeline is large, deep and visible but it remains 'lumpy'

Since the last Audit, Australia has moved into a period of unprecedented infrastructure construction activity. Engineering work for the public sector grew to its highest level ever recorded, while declining marginally in recent quarters, as shown in Figure 6. The lift in total work done has not been uniform, with the change almost solely the result of

increased expenditure by the Australian, New South Wales and Victorian Governments. Figure 6 also shows the 'lumpiness' of the overall pipeline, with commencements showing high levels of volatility.

This increase in overall work done is a good problem to have, but it is posing challenges to the market and government sector alike. There is a shortage of capacity, skills and resources to deliver these projects.

Figure 6: The total value of infrastructure work done for the public sector has reached record levels because of New South Wales and Victoria



Note: Bars represent value of work done per state, and the line represents value of work commenced nationally.

Source: Australian Bureau of Statistics (2019)⁹⁵

The concentration of general activity in New South Wales and Victoria is mirrored in the major project future pipeline, shown in Figure 7. This figure shows over \$130 billion in credible and committed, near term major projects in New South Wales and Victoria – while all other jurisdictions combined are fielding less than half the volume and value.

A number of factors have led to this unprecedented level of activity, including population growth, ageing existing infrastructure, political appetite and market conditions. Strong transport investment is the most significant contributor and is expected to stay elevated.

Despite reflections that Australia is currently undergoing a short-term infrastructure investment boom, project commitments within the short- and medium-term pipeline, and major unfunded long-term promises means new work is likely to stay elevated for more than a decade. Many of these long-term commitments, particularly urban rail enhancements such as the Outer Suburban Rail Link in Melbourne, MetroNet in Perth and Metro expansions in Sydney, will be delivered over many years.⁹⁶ Queensland's long-term outlook is also to strong continued investment, while short to medium term enhancements to the Bruce Highway and M1 Pacific Motorway will continue.

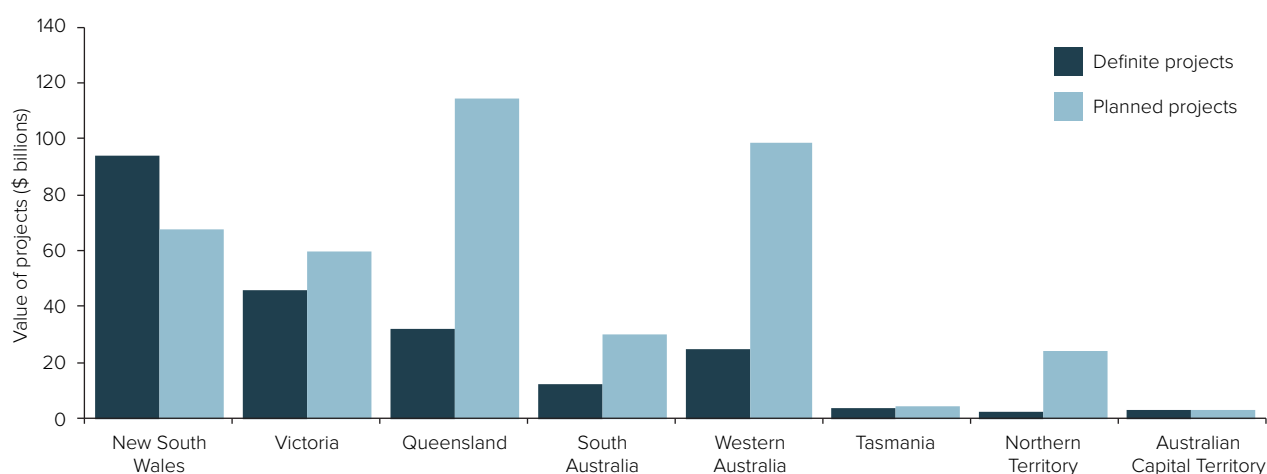
A strong project pipeline is therefore likely to dominate for a substantial period and governments and the market will need to adjust.

The visibility of the major project pipeline has markedly improved since the last Audit. This is a result of:

- Federal initiatives such as the Infrastructure Australia *Infrastructure Priority List* and the Department of Infrastructure, Transport, Cities and Regional Development long-term capital planning
- Individual efforts of jurisdictions including respective government infrastructure bodies
- Industry initiatives such as the Australian & New Zealand Infrastructure Pipeline, published by Infrastructure Partnerships Australia.

However, this increased visibility has not yet contributed to clearer coordination between jurisdictions. Similar projects on similar timelines continue to be released, in different parts of the country. This is most likely due to states and territories owning the responsibility for the majority of infrastructure delivery, the state of each jurisdictions' infrastructure asset base and the concurrent political priorities. The coordination of projects into the market has always been assumed as a natural benefit of greater transparency, however this has yet to materialise.

Figure 7: The committed major project pipeline is dominated by New South Wales and Victoria



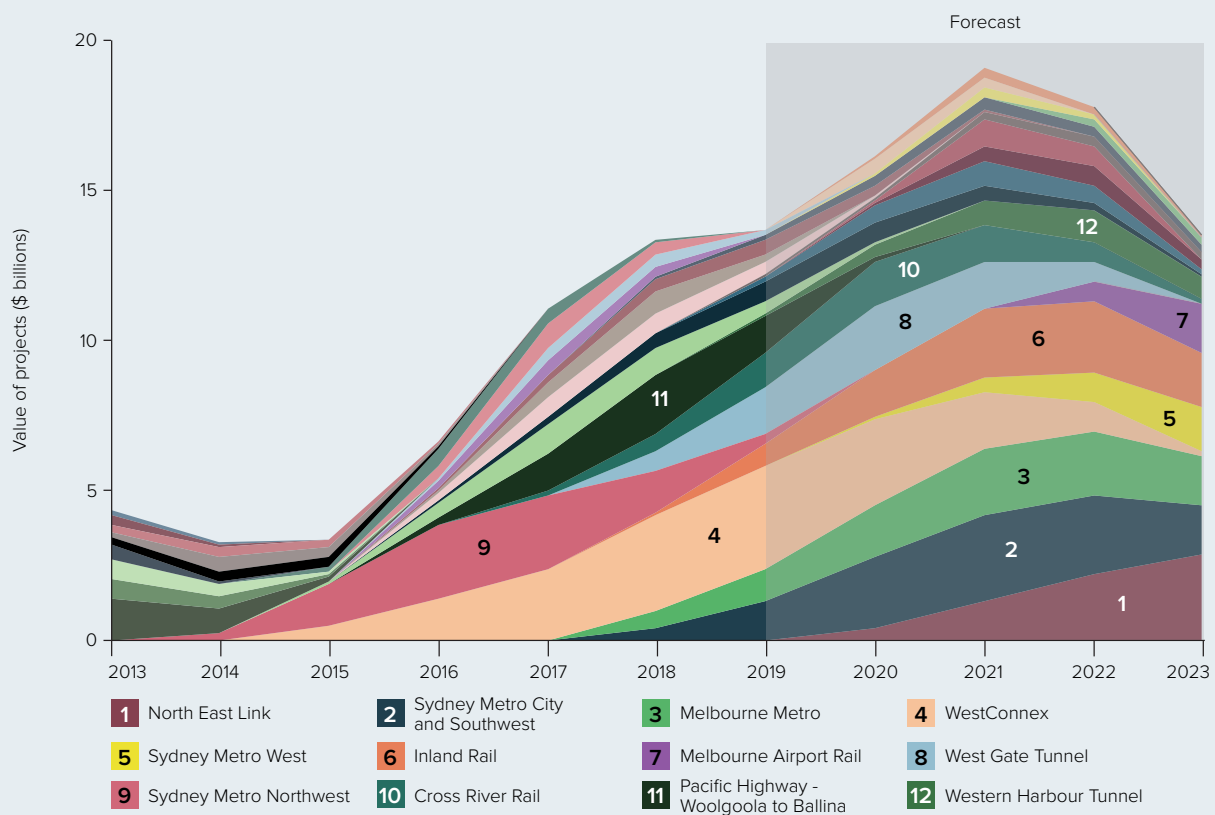
Source: Deloitte Access Economics (2019)⁹⁷

The transport infrastructure mega-projects pipeline is growing

Figure 8 shows a representation of transport mega-projects (those larger than \$1 billion in value). This chart highlights the significant growth in the major project pipeline and the significant demand for similar skills and resources, such as within the railway sector, that coincide over particular time scales peaking in 2021. In a heated, concentrated market a pipeline that lacks coordination increases the risk of low competition, or poor outcomes because the best teams were not available.

In reading Figure 8 it is also important to acknowledge government expenditure is inherently more certain within the four year forward estimates budget cycle. The certainty of the project pipeline tends to decrease from years 2 or 3 (2020 and 2021) before reducing more significantly in year 4 (2022). This is illustrated by the declining peak on these years. While this is a feature of current government budget practices, long-term planning and asset management can improve certainty to industry over longer periods allowing skills and capacity ramp-up.

Figure 8: The Australian road and rail infrastructure major projects pipeline has been growing



Source: Deloitte Access Economics (2019)⁹⁸

28. Challenge

Increased transparency of the infrastructure pipeline has not improved coordination on the timing and release of projects into the market, leading to some stretching of resources. A lack of coordinated procurement and delivery activity is resulting in constraints in key resources and skills.

When this will impact:



Where this will impact:



A ‘hot’ market has increased push back on risk by contractors

The delivery of infrastructure is dependent on the differing skills, resources and knowledge of the public and private sectors. To support the efficient delivery and operation of infrastructure, the public sector contracts the private sector for services they are better able to deliver. In many cases, this involves the construction of infrastructure assets, operations, financing and other services.

The use of private sector resources and expertise supports the delivery of value for money infrastructure delivery and operation for users and taxpayers, while also protecting the taxpayer from various risks. Best practice contracting and procurement ensures risks reside with the party best placed to manage them. This concept is core to the delivery of high quality, value for money services.

Since the last Audit in 2015, the make-up and risk-appetite of the infrastructure sector have changed. Large financial losses on some construction projects and a strong pipeline of work have caused the market to push back on a range of risks. These losses are at least in part the product of aggressive pricing by contractors seeking to maintain market share. Despite these challenges, in some cases poor allocation of some risks has also created distinct issues. For example, the transfer of regulatory risks and responsibility for negotiating with other government agencies, such as utilities, are key risks transferred to the private sector, which potentially could have been more efficiently managed by government.

The impacts of reduced risk appetites on securing competition for the delivery of projects is most prominent on mega-projects, where the capacity of the market is already limited because of the scale of these projects.

Australia’s larger contractors have large volumes of work in hand. They also have a wide range of choice in the forward pipeline. However, several are facing substantial losses due to troubled major projects. Together, these conditions have resulted in larger contractors ‘pushing back’ on risk transfer, particularly for very large projects.

Construction tiers

Tier one: A small number of large contractors capable of delivering mega-projects over \$1 billion without partnering. These major contractors are currently constrained by high volumes of existing work. Lead contractors on mega-projects often use international contractors and tier two contractors to reduce risk on very large projects.

Tier two: A small number of medium-sized construction firms that undertake projects up to around \$500 million, before requiring support of a joint venture partner. These contractors will lead smaller projects, particularly with well understood risks. They currently have a larger appetite for new projects, however they have less capacity to support large contracts and manage certain risks, such as those requiring specialised skills.

Tier three: A large number of smaller firms, generally with an appetite for projects under \$100 million. They are usually less willing to take aggressive price or risk positions.

In current market conditions, a challenge to public sector procurers of infrastructure is to consider adjustments to the risk allocation and scale of contracts issued to the market to ensure competition. For example, the New South Wales Government’s Rozelle Interchange project exceeded the market’s appetite and saw only a single bidder. This forced a fundamental revisit of the project’s commercial and procurement and delivery strategy to meet contemporary market appetite and capacity.

The aim of each procurement process will be to bring individual contracts within the capacities of the market to drive vibrant, value-creating competition. In some cases this may involve considering the structure of works packages, reducing their size or risk profile to suit market depth, capacities and capabilities.



Tier one contractors and larger tier two contractors seek to limit the degree of project risk they are exposed to. The challenge in procurement policy and strategy is to align the scale of the project, contracting model and risk allocation approach. In some instances the scale of works packages inhibit participation by tier 2 and 3 contractors, thereby limiting competition on a project that would otherwise be within the skills range and capability of these businesses.

To date, the response to the changing risk appetite has been inconsistent and uncoordinated. Subsequently the risk pendulum has swung unnecessarily far towards the public sector and ultimately the taxpayer, on some projects with the public sector holding risks comfortably managed by the private sector. This reduces value for money for taxpayers, whereby increasing infrastructure costs.

However in other instances, the transfer of excessive or inappropriate risks to the private sector has inhibited the ability for governments to reach financial close on some procurements, and lead to delivery risks and ultimately litigation in other projects. This also reduces value for money for taxpayers and increases the costs of infrastructure.

The misalignment and low coordination of projects between jurisdictions also reduces the ability for the private sector to manage a portfolio of projects, or varying sizes and risk profiles. As a result of the strong project pipeline, the private sector is able to reduce its exposure to risk through rebalancing its project portfolio. The private sector push back on risk is therefore likely to persist for at least the next five years. However, if the current levels of investment

continue as expected for longer and the depth of the market remains static, the current levels of risk tolerance may continue.

However, the future risk appetite of the industry is neither static nor certain. Changes to the scale, type and contractual sophistication of projects has implications for contractor risk profiles. With these changing market conditions and rebalancing in risk, it will be important to consider whether existing procurement policies and processes are appropriate. Procurement and contracting changes could have significant long term effects, such as resetting the norm for acceptable risk transfer.

Ultimately, the costs of poor procurement practices are borne by the taxpayer and infrastructure users through increased costs or reduced quality of infrastructure. Therefore jurisdictions have a strong imperative to improve procurement practices and increase coordination.

International contractors are unlikely to fill the void

Discussions about constraints for mega-projects often turn to the role of international contractors supplementing domestic industry capability.

International contractors, advisors and operators strengthen competition in the market by extending the financial and technical capability, and supporting the innovation and risk appetites of incumbent market participants. International design firms also provide additional innovations and capabilities in the design phase. Many infrastructure subsectors are dominated by international operators, including transport and water.

Austrade and various state agencies have made concerted efforts to support the increased presence of international contractors. A range of international contractors have entered the Australian market in recent years, including Bouygues, Samsung, Salini Impregilio, Dragados, Acciona and Bechtel.

However, new international entrants to the market can take a substantial amount of time and resources to upskill and acclimatise to Australian legislative and policy requirements. International contractors may also be unfamiliar with Australian regulatory requirements, community expectations or operational requirements. If not well-managed, these gaps in

knowledge and capacity can result in sub-standard project delivery, network integration or user outcomes. This poses additional risks to procuring agencies, who may need to support and guide foreign participants.

Sustaining competition in Australia's construction market, including its attractiveness to foreign industry participants, is integral to high quality outcomes for the community. Recent steps by some jurisdictions to encourage foreign suppliers to the market has supported affordable, high quality infrastructure for users in those jurisdictions.

29. Challenge

The overall volume and project scale of infrastructure construction has created a heated, stretched construction market and reduced competition for projects. High risk projects are not achieving a desired level of competition during procurement. This may result in delivery being delayed or delivered by a higher risk, lower skilled contractor.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Construction sector productivity is lagging

Concerns about efficiency and productivity are commonplace within many countries.⁹⁹ Internationally the average annual growth in construction sector labour productivity averaged 1% over the past two decades, compared with broader economic growth of 2.8% for the total world economy.¹⁰⁰ In contrast, productivity of the Australian construction sector declined by around 2.5% between 2017 and 2018, on an hours worked basis.¹⁰¹ Multifactor productivity within the construction sector has declined for each of the past four years. However, productivity is not consistent across states and territories, with New South Wales historically performing well.¹⁰²

It has been estimated that a 1% increase in construction sector efficiency would result in an approximately \$500 million saving to the taxpayer, however this is dependent on industry activity at that time.¹⁰³

Low levels of productivity improvement have previously been linked to low levels of capital investment, such as in plant and machinery, which would increase an individual's productivity.¹⁰⁴ However, high rates of workforce turnover, low workforce morale, low levels of investment in training and education and other sector culture factors are likely to compound the productivity plateau.¹⁰⁵

The transformation of the workforce to a higher level of digitisation will present new opportunities to improve productivity. Construction is currently one of the least digitised sectors.¹⁰⁶ The application of emerging technologies such as drones, building information modelling (BIM) and 3D printing offer the potential opportunity to support productivity improvement. The improved use of data and enhanced communication with clients and customers has been identified in the United Kingdom as offering the potential to enhance productivity within the construction workforce.¹⁰⁷

The reluctance of employers to invest significantly in workforce development, and the subsequent lag in productivity, may be linked to low levels of confidence regarding the future project pipeline and a perception of an elevated level of market activity. While the transparency of the project pipeline has improved significantly since the last *Australian Infrastructure Audit* in 2015, little further analysis to support the implications of the pipeline for workforce needs has been developed. Noting the expectation that work levels will likely remain elevated for several decades, improvements to workforce skills forecasting provides a significant opportunity.



The skills of the public sector are as critical as the private sector

High-quality outcomes across project procurement and delivery require the achievement and sustenance of commercial symmetry between the public and private sectors.

High quality procurement and project management skills within the public service support value for money outcomes for users and taxpayers, while minimising unforeseen risk to sector participants.

The potential contribution of a skilled public sector procurement or project manager is therefore substantial. There is a strong case for the public sector to employ and develop highly skilled candidates with these skillsets as they hold a disproportionate ability to drive value for money outcomes for the government and taxpayer, while also supporting a well-functioning and stable industry.

Since the 2015 Audit, progress has been made in the formation and enhancement of specialist procurement, financing and commissioning units within various jurisdictions. These centralised skills supplement industry and project specific capability within line agencies. However, despite these changes, the increased volume of procurement and project delivery is stretching the public service, as well as the private market.¹⁰⁸

Expertise in the evaluation of projects, including the development of business cases and the application of CBA, has additionally been identified as an area of concentrated industry capacity in both the public and private sectors. While the overheated market is leading to over-stretched public service resources in fast-growing cities, the capacity of the local public services is less well-developed in some smaller cities and regional towns, including some smaller capitals.

The most common cause of poor business case development, and subsequently poor procurements is inadequate scoping.¹⁰⁹ Improved problem definition is critical to allow appropriate, value for money solution design and to manage project risks. While more contemporary insights would be valuable, the *Scope for Improvement* prepared by Blake Dawson with Infrastructure Partnerships Australia and the Australian Constructors Association regularly identifies scoping inadequacies as attributing to cost overruns (61%), delayed completion (58%) and disputes (30%).¹¹⁰ The 2008 Report identified insufficient competence as the major cause of inadequacies by 45% of respondents, while the 2014 Report found skills had declined.

There is an opportunity for governments to greater prioritise the development of commercial, financial and project skills amongst the public services in order to reduce total project costs, avoid cost overruns and disputes.

30. Challenge

Despite meaningful progress in key jurisdictions and large agencies, the public sector is inadequately resourced and skilled to undertake a high volume of sophisticated procurement activity, including the oversight of projects during the delivery phase. Inadequate public sector procurement expertise can result in the taxpayer being exposed to inappropriate risks or costs, and compromising the capability of projects to achieve user outcomes.

When this will impact:

0-5

5-10

10-15

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Where this will impact:



Australia faces infrastructure sector skills constraints

At all levels and for all types of infrastructure, access to appropriate skills is a problem. For major projects in fast-growing cities, the largest skill constraints are among professional project managers, bid teams and skilled labour. Key professional skills, especially in the rail sector, electricity transmission construction and maintenance as well as emerging technology sectors, are impacted by skill shortages.

For example, the demand for rail industry skills are expected to rise by 5.5% from 2018 to 2023.¹¹¹ Skills constraints are expected to impact frontline operational staff including drivers as well as technical skills such as signalling technicians. The sector will experience challenges meeting this requirement compounded by a decline in the proportion of national rail workforce of under 40, when compared to those over 40, of 4.4%.¹¹² The sector also lacks diversity. The workforce is currently over 80% male, with the gender imbalance potentially reducing attractiveness of the industry to some female recruits. Future technological changes, including the introduction of automation, are expected to fundamentally alter the structure of the rail workforce

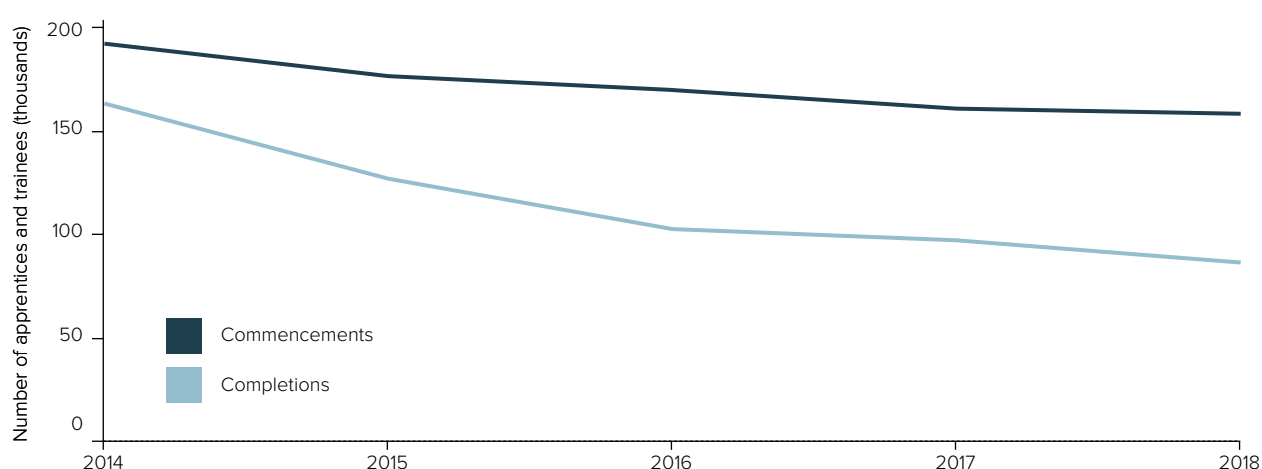
over coming decades with a decline in some frontline skills and a greater reliance on technical infrastructure roles, such as signalling.

In regional centres and remote areas, on top of the national skills constraints, labour shortages affect most levels of the workforce including attracting and retaining semi-skilled construction workers. These labour constraints present opportunities for developing local workforces, if project pipelines are certain and well understood sufficiently in advance of the skills being required.

Despite the growth in infrastructure volumes, commencements and completion of apprenticeships across the economy have continued to trend downwards, see Figure 9. The decline in apprenticeship commencements alongside the ageing of the technical skills workforce, is likely to further compound shortages of key skills.

The Sydney Metro project is a good example of planning ahead. The Sydney Metro project team entered a very early partnership with TAFE NSW, to train a work-ready near-entry level workforce.¹¹³ This program also focused on Aboriginal and Torres Strait Islander participation, with reportedly strong retention results.¹¹⁴

Figure 9: Commencements and completions of apprenticeships and trainees have declined over time



Source: National Centre for Vocational Education Research (2018)¹¹⁵

Industry culture can hinder talent attraction and retention

The Australia infrastructure sector is a collection of relationships between clients and project teams, partners and competitors, with a relatively small number of organisations, each of which may fulfil various roles from operator to advisor, contractor to investor. The concentration in the market is particularly notable for large projects and within specific sectors. The culture of the sector therefore varies from sector to sector, however also from firm to firm and profession to profession.

Some common characteristics of the domestic infrastructure market include:

- Short-term project based relationships – leading to a culture prioritising short-term ‘wins’ rather than long-term community outcomes
- Project based workforces – reducing the focus on long-term workforce development
- Fragmented supply chains – accentuated by Australia’s isolation in global markets, and amplified in remote areas
- Industrial relations constraints – outdated industrial practices remain a consideration within the sector, particularly for public sector workforces or those traditionally part of the public sector
- Disjointed corporate knowledge – large and complex projects do not occur with sufficient frequency to instil specialised knowledge or supplier relationships.

An absence of trust between client and contractor, and community and construction project teams presents a cultural challenge for the sector as it seeks to continue the current level of activity. Communities experiencing so-called ‘construction fatigue’ will be less willing to endure disruption to facility construction if the lead contractor has not been able to establish trust with the local community.

Similarly, over recent years, at a jurisdiction to jurisdiction level, the sector culture has evolved to have a strong focus on securing projects within

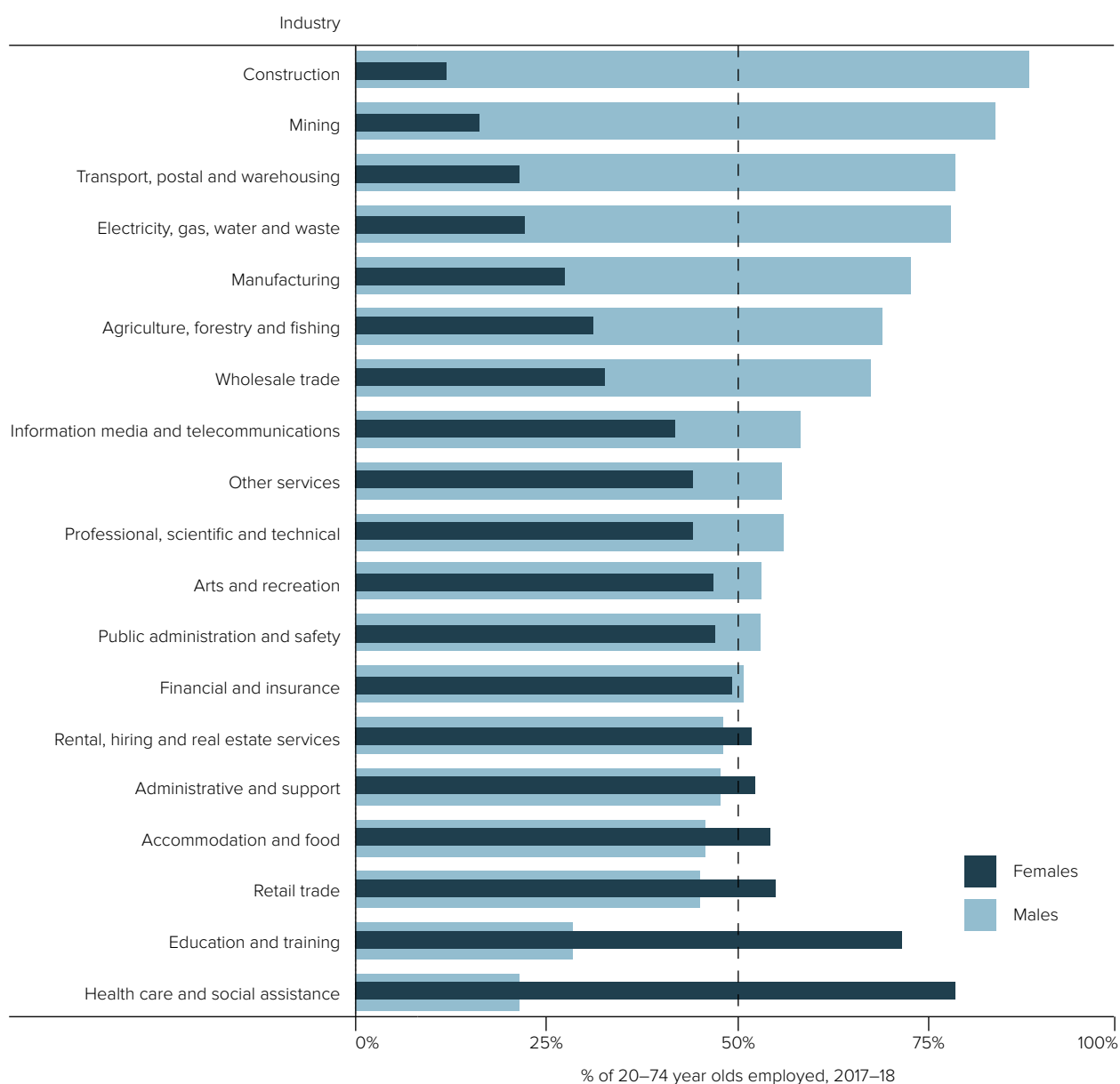
a highly competitive market. Subsequently, some contractors have shifted their operational model to low costs bids with a greater emphasis placed on the use of contractual variations and other mechanisms to ensure profitability. This approach is not consistent with a long-term sustainable sector and is likely to reduce partnership and cooperation.

Greater recognition within the sector that the current level of activity is a norm, rather than a boom, could provide a catalyst for a shift in behaviours and a renewal of industry culture as a normal manner of relationship is re-established.

Within some professions, a strong and distinct culture has developed. In particular construction and engineering are well-known as strongly male-dominated professions. The construction sector is Australia’s third largest employer, yet it has the lowest levels of female workplace participation of any industry, see Figure 10. Female participation within the sector has declined in recent years. Representation of women is low and declining, with gender bias identified as a potential barrier along with gender pay gaps, and industry practices, such as long work hours.¹¹⁶ For example, John Holland Group has identified that that 15% of the women in the workforce were being paid less than their male counterparts.¹¹⁷

The lack of engagement of women within the construction sector restricts access within the industry, which is currently experiencing skills and labour constraints, to women who make up the majority of the population. The closure of the industry from this significant pool of workers has been the focus of significant government focus over previous years, including the promotion of Science Technology, Engineering and Mathematics (STEM) education.¹¹⁸ However, the lack of significant progress in the participation of women within the sector despite this investment warrants closer examination.

Workforce wellbeing is also impacted by long-hours and limited opportunities for advancement or the development of skills. Threats to workforce physical and mental health also persist. In particular, high rates of male suicide present a key risk to the sector.¹¹⁹

Figure 10: The construction and mining industries have the lowest levels of female workplace participationSource: Australian Bureau of Statistics (2018)¹²⁰

31. Challenge

Skill constraints are affecting key roles within the sector. The entrenched construction sector culture is limiting the sector's attractiveness to potential future employees.

When this will impact:

0-5 5-10 10-15 15+

Where this will impact:



4.5 Procurement and contracting

At a glance

Infrastructure outcomes for users are strongest where considerations of whole-of-life project outcomes are acknowledged and deliberated upfront.

This sections examines:

- Whole-of-life and user project outcomes
- Innovations in contracting to support user outcomes, including unsolicited proposals
- Bid timelines and tendering costs
- Risks posed by accelerated procurement and delivery.

Contracting innovations can support user outcomes

The involvement of the private sector in the delivery of infrastructure services is well established in most infrastructure sectors, from hospitals to water and bus services. The involvement of the private sector through service contestability has in many cases prioritised value for money outcomes for the taxpayer.

However more recently, procuring agencies have matured their contracting models in order to better prioritise improved services for users. Recent public transport franchising and other service contracts in major jurisdictions have given at least equal priority to customer outcomes in procurement decisions. A significant, but important, step since the last Audit in 2015 is the move from many governments from the prioritisation of 'lowest cost' to 'value for money' procurement outcomes, allowing improved services for the community to be considered within procurement processes.

For example, the introduction of contestability to Sydney's Region 6 Inner West bus contract supported the introduction of electric buses, on-demand services as well as an increase in services by 20%.¹²¹

However, existing infrastructure contracts such as public private partnerships (PPPs) regularly range up to 40 years, making revision to support customer outcomes difficult. To emphasise the challenges, casting back 40 years from today personal computing, smart phones and the sharing economy were largely unknown. For example, privately operated motorways are required to provide emergency broadcasting capacity using the dominant entertainment broadcast mediums FM and AM radio from the time of their contract, however do not have the same obligations to provide digital radio broadcasting.

In order to ensure infrastructure services are able to cater for contemporary user requirements in a rapidly changing environment, changes to the way long-term contracts are designed and renewed will be critical. Similarly contract managers entering long-term service contracts today will face a similar challenge heightened by the accelerating rate of technology change. Governments, procurement managers and their advisors will need to consider how to predict or anticipate changes in user needs and preferences over this period and avoid contractual arrangements that lock-in outdated service standards or outdated practices.

In many jurisdictions a focus on value for money, whole-of-life and user outcomes in contracting is not consistently applied in infrastructure contracts. In these jurisdictions, an opportunity exists to embed user-orientated performance metrics, renegotiation clauses and specific needs as contracts are periodically re-tendered. This incremental progress will support user outcomes ahead of more significant future contract innovations.

Elsewhere, contract innovation has focused on the enhancement of user outcomes and the provision of value for money service enhancements. Most notably, the introduction of the Newcastle Integrated Service Offering, also known as Newcastle Transport, is the first multi-model public transport contract in Australia contracted on a geographic region. The contract combined bus, ferry and planned light rail service provision into a single contract. The contract additionally provided the private operator significant scope to redesign the bus network and increased risk-based incentives to grow patronage. The contract also facilitated the introduction of on-demand transport services to New South Wales.¹²²

Capital investment is unbalanced despite whole-of-life priorities

Infrastructure is not an ends to itself, rather it is the means for delivering a range of services to the community. Despite the importance of the services that infrastructure provides, too often the priority is given to capital works and new infrastructure builds over policy reform or maintenance.

The preference for capital expenditure is influenced by the increased availability of funding, including intergovernmental grants, community support and the potential to use new infrastructure builds to reduce existing maintenance obligations.

However, large and capital intensive projects can in practice create new long-term maintenance obligations for governments and communities. For example, market rules allowed network operators to overinvest in electricity networks, resulting in increasing payments to network owners and increased bills for consumers.¹²³ The current high levels of new capital works is likely to transfer into increases in asset maintenance obligations, compounding maintenance requirements that are not currently being fulfilled.

Within the development of project business cases seeking support from the Commonwealth Government, we have observed reduced priority being given to low-cost alternatives. Often business cases only pay lip service to cheaper non-capital solutions, which can reduce costs to users and taxpayers. In their place, high cost project opportunities are put forward potentially influenced by a desire to secure higher levels of funding support. This preference for new-build risks exacerbating the existing maintenance deficit.

In circumstances where step changes in service standard are required, large capital investments have the potential to unlock major changes in economic, social and environmental outcomes. However, non-capital alternatives, like policy and regulatory reform, or maintenance and minor capital works, can also deliver significant benefits and address user needs.

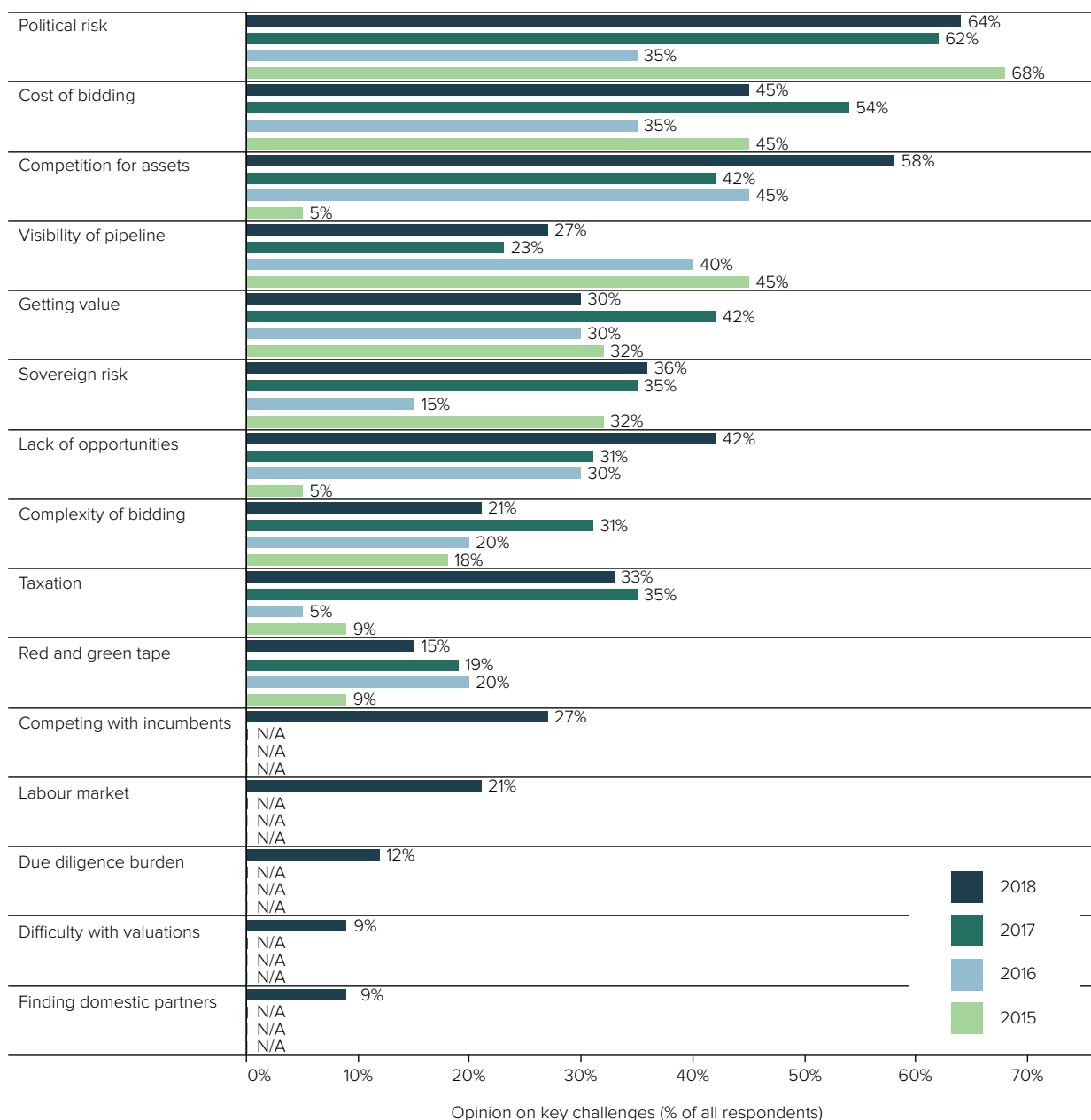
Bidding timelines and tendering costs present a barrier to competition

High levels of activity within the market have resulted in constraints on public sector procurement resources. Within many jurisdictions, these resource constraints have in-turn led to truncated procurement timelines. This inhibits the ability for new market entrants to compile compelling offers and increases risks for both successful proponents and client agencies.

For major projects, the cost of tendering remains a large expense for contractors, making it harder to attract suitable competition. There are a range of opportunities that have been identified by a range of works, including by Infrastructure Australia, could be adopted to lower inefficient costs during the contract bid phase:

- Early announcement of projects
- More consistent and rigorous application of guidelines for procurement model selection
- Rationalising information requested that are not material to the evaluation of bids
- Recruitment, development and retention of high quality government project team members¹²⁴
- Jurisdictions making partial reimbursement of bid costs to unsuccessful parties. Some of these payments are up to 50% of eligible pre-estimated bid costs.¹²⁵ Direct reimbursements are likely to continue to be a key response to attract competition for major projects over the next 0-5 years.

These initiatives will serve to mitigate the challenge of high bidding costs, shown as the third most significant challenge to investing in Australian infrastructure in Figure 11.

Figure 11: Political risk, bidding costs and competition for assets have been identified as the top market inhibitors in 2018

Source: Infrastructure Partnerships Australia (2018)¹²⁶

Due to the reduced capacity for certain contractors within the sector to tender, larger tenders will require clear processes and bidders will require clarity about the size of the shortlist that will be used for the bidding phase.

Generally, the public sector has shown a preference for shortlists with more than two bidders. This is to ensure competition in the event that a party withdraws from the bid. While this has occurred for some significant and high-risk projects, notably Sydney Light Rail, there is a risk that the market will not be able to sustain this for multiple larger contracts.

In the current environment with a substantial project pipeline, many companies would rather 'lose early' than 'lose late' due to the financial impost and the

opportunity cost of bidding. The private sector is more likely to commit to procurements that limit shortlists to an appropriately small field. This will in-turn reduce infrastructure costs, as successful bid costs are ultimately recovered on future projects.

The New South Wales Government's Construction Leadership Group, in partnership with industry, has also recently committed to develop and publish simple guidelines which document contemporary and best practice procurement method selection for projects and, when appropriate, work packages within projects.¹²⁷ The work of this group presents an opportunity to support a foundation for national best practice.

32. Challenge

Truncated bidding timelines, unnecessary documentation requirements, and under-resourced government project teams are leading to poor procurement and delivery outcomes. This results in higher levels of risk and uncertainty being priced into tenders. These costs are ultimately carried by the users through poor quality services or additional costs, or met through government reimbursements.

When this will impact:

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Where this will impact:



Fast tracking procurement and delivery can be costly

There is an inherent tension between the time required to identify, scope, compete and commission major projects, versus the political and community desire to see progress on (or under) the ground. This has been enhanced by the sheer scale and volume of major projects under consideration or in delivery.

For mega-projects, the planning and bidding phases alone may take several years. The scale and complexity of Australia's current major transport projects include projects with delivery timelines nearing a decade.

This tension puts pressure on governments to reduce planning and procurement timelines. In some cases, this has resulted in inadequate understanding and scoping of projects risks, or a misallocation of risk between parties.¹²⁸

Where timelines are shortened by political priority or poor procurement and commercial advice, it is taxpayers and users who ultimately absorb the costs and delays, or endure a service that is poorly integrated into existing networks. Recent examples include the Tibby Cotter Bridge in Sydney, Adelaide Rail Network Electrification, Sydney Light Rail or the Moreton Bay Rail Link in Brisbane. These projects either saw major cost rises or major programme delays linked in-part to inadequate project planning.

In recent decades, procuring agencies have adopted more sophisticated contracting models that protect the taxpayer, through the use of PPPs, Design and Construct (D&Cs) and Design, Build, Operate and Maintain (DBOM). These approaches take longer and cost more to bid than lower risk models, like alliances or construct only. This is due to the competitive processes and detailed due diligence performed by procuring agencies and the market. However, these processes are important in securing long-term value for money outcomes.

Project costs can be grossly underestimated. The 2014 *Scope for Improvement* report, published by the Australian Construction Association, attributes 'political imperatives' as a major factor causing insufficient time for project scoping and planning.¹²⁹

In many cases this is due to political promises made in the context of elections. Significantly, community pressure often leads to political commitments during election processes. However, due to caretaker provisions limiting the role of the bureaucracy at this time, it is highly unlikely political representatives have access to appropriate skills or information to appropriately cost a project during this time.

Large, complex projects require careful consideration of risks and a considered process to allocate and manage these risks. With good commercial advice, prudent gateways and careful delivery oversight, the community can expect better value, better designed and better quality infrastructure.



33. Challenge

Community pressure can encourage premature project commitments or the acceleration of project delivery. Decision makers are often poorly resourced to respond to this pressure and arrive at an informed decision. Poorly planned, budgeted or scoped projects can result in project cost blow-outs or delays, as well as a failure to meet project objectives resulting in long-term costs to users.

**When this
will impact:**



**Where this
will impact:**



Unsolicited proposals have become the de facto path for asset enhancements

Since the late 2000s, many states and territories have adopted guidelines to support the receipt and assessment of unsolicited or market-led proposals. The development of these guidelines is an evolution of processes that previously existed, such as the New South Wales Government *Working with Government Guidelines*.

While unsolicited proposals have broader application than the infrastructure sector, the long-term contracts and asset lifecycles that define the sector has led to their use principally on infrastructure assets.

These processes are an important mechanism for the private sector to support the reprioritisation of infrastructure delivery and to support innovative delivery models. They are designed to provide a pathway for consideration of innovative sole-source project proposals from the private sector, where the private sector has a unique ability to deliver the project.

The majority of proposals received by government do not progress. This is due to either a deemed absence of 'uniqueness', a lack of strategic alignment with broader government investment and planning, or a general lack of government support for the proposition. Despite the relatively small number of projects that do progress, the unsolicited proposals approach has delivered multi-billion dollar projects, including road enhancements, student accommodation, tourism developments and urban renewal.¹³⁰

These frameworks have been successful in securing the progress of projects aligned to government priorities. However, they have also exposed the shortcoming of pre-existing contractual arrangements that provide limited opportunity for incumbent infrastructure owners and operators to propose asset improvements or enhancements within existing contractual arrangements.

For example, the unsolicited proposals process in New South Wales and the market-led proposals process in Victoria have been used to assess proposals to widen and enhance heavily congested urban motorways in Sydney and Melbourne.¹³¹ The use of these frameworks acknowledges the limited mechanisms within the existing contracts to address congestion on these assets.

This necessity to use the unsolicited proposals approach exposes the shortcomings of the current approach to contracting. The requirement for asset enhancements to be progressed as unsolicited proposals reduces their ability to be considered as part of broader strategic planning by government and means private infrastructure owners and operators need to take on higher risks and costs to progress asset enhancements.

Ideally, unsolicited proposals or market led proposals should be an exception, rather than a routine way to procure infrastructure or infrastructure enhancements. Where agencies and the public sector have a better understanding of long-term public need and this is considered upfront in contracts, fewer unsolicited proposals or market led proposals would be required.

4.6 Security, resilience and sustainability

At a glance

Our infrastructure networks face unprecedented risks from technology, economy, evolving user preferences and climate change. Yet our resilience strategies do not provide enough guidance.

Typically, it is cheaper to build with risk in mind than to retrofit existing infrastructure. Furthermore, making our infrastructure more sustainable is critical to future success, including achieving our international emissions reduction targets.

Infrastructure networks are facing unprecedented risks

Australia's infrastructure networks face a series of complex and interconnected risks. As our digital connectivity and the impacts of climate increase, the likelihoods, specific nature and consequences of risks are changing. For example:

- **Technology:** New technologies and systems are becoming more sophisticated and complex, and are also more central to our lives and span a larger and more geographically dispersed range of service providers. As the complexity of networked systems grows, there is potential for failures and disruptions that are more difficult to predict and more pervasive in their impact.
- **Security:** Infrastructure is facing mounting risks from a range of security threats, including potential malicious attacks on critical assets. In particular, cyber security is an increasing risk, with the growing reliance on digital systems to support operations across all sectors introducing new and evolving vulnerabilities.
- **Economy:** Economic risks brought by greater exposure of Australia to global markets and competition from growing and developing Asian nations can cause uncertainty in demand for domestic supply chains and freight hubs. Changing world attitudes to free trade could impact on parts of our supply chain infrastructure networks.
- **Changing preferences:** Changes in user behaviour can also lead to rapid changes in user demand, placing some assets under increased strain or making others no longer fit-for-purpose, or even redundant.
- **Environment:** In a changing climate, infrastructure faces conditions different to those for which it was designed. This includes higher temperatures, higher and lower stream flows, changed seasonal rainfall and water availability, changed soil conditions, more intense bushfires, more extreme winds, and rising sea levels, causing coastal inundation and erosion. Climate change is bringing risks.

Resilience is not well-reflected in planning processes

Planning for resilience requires an understanding of the full scope of risks, their likelihood and the potential economic, social and environmental costs of outages, damage, disruption or failure. Timely access to evidence that aids the evaluation of likelihood and consequence can help the planning of construction, maintenance and resilience.

However, evidence about the scale of risks, their impacts and the costs of addressing them is often weak or not accessible. In some cases, risks are known but very technically complex and only a few people have the skills to assess them. In other cases, risks may require specialised and expensive modelling to assess. In a rapidly changing environment, risks shift in nature and severity, complicating assessment. This can lead to reactive, rather than proactive, responses to both short-and long-term risks to networks.

Australia's infrastructure sector lacks clear, publicly available guidance on how to manage risk and plan for greater resilience in the future. Those that exist are already outdated, for example, the Australian Government's *Critical Infrastructure Resilience Strategy* brought together the perspectives of government, industry and enforcement agencies through the Trusted Information Sharing Network in 2015 – meaning it does not reflect new dependencies and technologies such as the Internet of Things, blockchain and drones.¹³² Also, where they exist, many asset management plans do not reflect the whole-of-lifecycle benefits and costs of managing risks to balance appropriate levels of risk and cost. This can lead to inappropriate designs, specification and operating procedures.



34. Challenge

Anticipating and mitigating against ever-changing risks to infrastructure is becoming more difficult as assets and networks become more interdependent and complex. Australia lacks comprehensive resilience strategies for its assets and networks. A failure to appreciate and plan for risks to infrastructure may impose substantial financial, social and personal costs.

When this
will impact:



Where this
will impact:



Cyber disruption transforms old risks to a new scale

The threat of cyber disruption or attacks is not only increasing, but becoming more complex.

The 2017 *Independent Intelligence Review* found that 'defensive and proactive technical security measures will increasingly be at the core of strategies to secure systems and data. Whether it is in relation to data analytics, encryption, decryption, data protection generally or the use of cyberspace, collaboration and co-operation between Australia's intelligence agencies and the private sector will become increasingly necessary and relevant.'¹³³

The capability already exists for a cyber-attack to crash a car, pacemaker, and home security system or switch off a power grid.¹³⁴ The imminent arrival of vehicles that can operate themselves under certain conditions (level 3 automation), the prevalence of smart devices (almost 90% of Australians accessed the internet through their mobile phone in 2018, and over one-third of households own a smart TV)¹³⁵ as well as the growing dependence of a range of infrastructure services on telecommunications will increase the threat to life and the economy from cyber-attack.

As cyber threats become more complex and pernicious a great imperative will exist for governments and industry to ensure they are protecting critical infrastructure, particularly telecommunications networks.

Climate change impacts will vary across the country

Australia is a large and diverse continent, from the northern tropics to the tip of Tasmania. The impacts of climate change on different areas will be as diverse as their existing climates. For example:

- Coastal communities are already experiencing the effects of sea level rise
- Our cities are experiencing the impacts of the urban heat island effect

- Communities in inland areas are experiencing increasing incidence and intensity of drought
- Bushfires are increasing in intensity and the season is increasing in length
- Buildings and infrastructure assets across the country are needing to withstand more severe weather and changing temperatures. In northern Australia, increased intensity of cyclones threaten not only road infrastructure, but also water and wastewater, energy and telecommunications networks.¹³⁶

The cost of modifications to existing infrastructure, and the additional costs within new assets to cope are major climate adaptation challenges are not well understood.

The Reserve Bank has spoken of the impact of climate change on monetary policy and the economy, and noted existing data gaps and that major corporations are increasingly factoring in and disclosing climate risk.¹³⁷ A sampled majority of ASX 100 listed entities have considered climate risk to some extent.¹³⁸ The cost of insurance and costs of finance are rising to reflect these heightened risks, and some may find it difficult to source appropriate levels of insurance.¹³⁹

The Australian Government *National Disaster Relief and Recovery Arrangements* provide relief to states and territories in the wake of disasters, including for freight subsidies and reconstruction of essential public assets such as transport, water and social infrastructure.¹⁴⁰ The level of funding provided is linked to the pre-disaster function of the asset. Although only a funding guideline, this may constrain a case to build to a higher standard than pre-disaster function based on a long-term saving to taxpayers from a more resilient building design, or conversely to build to a lower standard reflecting a more frequent need to rebuild.

35. Challenge

Climate and cyber risks are likely to pose considerable and growing threats to Australia's infrastructure. Enhanced consideration of the risks to infrastructure can assist planning, design and operation of assets and networks, and can improve the resilience of services and reduce costs to future generations of users and taxpayers.

When this will impact:

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Where this will impact:



A whole-of-life view can lead to better upfront decisions

There is a well-accepted imperative to reduce the costs of construction of major projects, through avoiding high cost solutions and waste. However, when the whole-of-life costs of maintaining an asset are well considered and understood, in many instances there is a case to invest more up front to avoid or reduce future costs.

Ensuring better consideration of whole-of-life costs can be done through improved budgetary planning. This may include the use of whole-of-life contracting, and is often identified as a benefit of long-term outsourcing or the use of PPPs.¹⁴¹ Many of these benefits may also be achieved by placing responsibility for infrastructure construction and subsequent maintenance on a single client or provider.

More sustainable construction and operation of assets can minimise the upfront impact of infrastructure on the local and broader environment and reduce the total footprint of structures over their asset lives. Typically, retrofitting infrastructure to mitigate or avoid a known risk is more costly than initially building to address the risk.

The Australian Sustainable Built Environment Council (ASBEC), representing the built environment sector, has estimated that taking a building by building approach to emissions reduction could deliver almost \$20 billion in savings by 2020, and contribute to achieving a quarter of the emissions reduction required to meet Australia's Paris carbon emissions target.¹⁴² ASBEC points out that buildings may be at the cheaper end of abatement options, through implementing energy efficiency, fuel switching, rooftop solar and smart retrofitting of existing buildings.

Urban design can enhance natural features and incorporate them into places, broadening access to natural elements in urban areas, and protecting resources from degradation through over-development and pollution. Urban design can also support more sustainable user behaviour by minimising the need for travel by private vehicle and enabling public and active transport to meet most users' needs. Improved telecommunications can influence travel decisions, bringing local access to jobs and services or reducing the need to travel.

36. Opportunity

Australia could lead the world in developing and applying sustainability-enhancing approaches to its infrastructure. Taking the lead on sustainable infrastructure practices can benefit current and future generations of Australians, while providing opportunities for our businesses to share their expertise and innovation through exports and international development programs.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:





Australia is at risk of failing our international emissions commitments

Australia's emissions are among the highest in the world in per-capita terms – higher than the United States of America, and more than double the G20 and European Union average.¹⁴³

Our infrastructure accounts for more than half the national total, with transport, electricity generation and waste contributing 297 million tonnes of greenhouse gases.¹⁴⁴ The largest contribution to emissions is from the electricity sector, with 34% of emissions, mainly from combustion in coal- and gas-fired power stations. Transport is the next largest, with mainly tailpipe emissions from the combustion of petrol and diesel, totalling 19%. Emissions from waste, mainly via fugitive methane in landfills, adds a further 2%.¹⁴⁵

Infrastructure also contributes indirectly to a further 29% of our emissions inventory. Of this, 19% of total emissions are from the direct combustion of gas for energy in the form of heat, steam or pressure (and separate from electricity generation and most transport). This includes industrial production processes, as well as gas heating in households and commercial buildings. Also, a by-product of the extraction of fossil fuels are uncaptured (fugitive) emissions to atmosphere. This accounts for 10% of Australia's emissions.

In terms of trends, it is notable that:

- Emissions from electricity generation have fallen about 10% over the last ten years and this is expected to accelerate as 10 gigawatts of renewable energy are planned to come online during 2018 and 2019.¹⁴⁶
- While vehicles are becoming more fuel efficient and there is an increasing share of more efficient diesel, transport emissions grew by 4% from 2012 to 2016, while vehicle kilometres travelled increased by 7%.¹⁴⁷
- Direct combustion emissions are expected to rise by 7% out to 2020, driven by gas combustion at a growing number of liquefied natural gas facilities and mining sector growth.¹⁴⁸
- Fugitive emissions have grown considerably with emissions from coal mines and new gas plants coming online over recent years.¹⁴⁹
- Solid waste and wastewater treatment emissions fell steadily until 2015 with improved processes and the capture of methane from landfill sites. Emissions have since flattened.¹⁵⁰

These trends are placing Australia at risk of not meeting our 2030 emissions reduction commitments as part of the Paris Agreement.¹⁵¹ Our infrastructure sectors therefore have a key role to play if Australia is to achieve these commitments.



37. Challenge

Australia is at risk of not meeting its 2030 Paris Agreement commitments to reduce emissions by 26-28% below 2005 levels, in part driven by increases in transport, direct combustion and fugitive emissions. Without action in these sectors to reduce emissions, Australia risks becoming one of the highest carbon emitters per capita in the world.

When this will impact:



Where this will impact:



4.7 Challenges and opportunities

Planning and decision making

20. Challenge

Decision-making processes across many jurisdictions and sectors are not meeting best practice standards, including application of the *Infrastructure Decision-making Principles*. Failure to improve project decision making is likely to reduce the potential productivity and quality of life improvements of infrastructure investments.

When this will impact:



Where this will impact:



21. Challenge

Many decisions are being made without meaningful engagement, and without the means for comment and stakeholder feedback to inform project planning and delivery. By not adequately engaging, governments and proponents miss the opportunity to address stakeholders' concerns, ensure projects and reforms meet their needs, establish social licence and build trust in decisions.

When this will impact:



Where this will impact:



22. Challenge

Across many infrastructure markets, regulatory principles are complex, inconsistent, do not sufficiently protect the long-term interests of users, and reporting does not always align with user outcomes. A lack of clarity on user-focused objectives is likely to lead to worse outcomes for many users, and frustration with the perceived complexity of markets and decision making.

When this will impact:



Where this will impact:



23. Challenge

How infrastructure is provided and used will transform over coming decades, meaning laws and regulations will need to be reviewed, removed or updated. Failing to anticipate and adapt to change will undermine Australia's global competitiveness, stifle innovation and reduce the benefits of productivity-enhancing technologies.

When this will impact:



Where this will impact:



Funding and financing

24. Challenge

Funding for public infrastructure has risen above historic trends, but remains below that of many OECD nations and may need to rise further to maintain or improve user outcomes. Without sufficient funding for public infrastructure, outcomes for users will deteriorate over time, undermining productivity and quality of life.

When this will impact:



Where this will impact:



25. Challenge

Many community service obligations lack transparency, are not frequently reviewed, and may be inefficient. Opaque funding arrangements erode community support for CSOs and the benefits they deliver, while the lack of consistent review processes means taxpayers cannot be sure that this funding is efficient and delivers value for money.

When this will impact:



Where this will impact:



26. Challenge

A historical underspend on preventative maintenance, short budgetary and funding cycles, a lack of data and incentives, and inadequate reporting have contributed to a maintenance funding backlog across infrastructure sectors. An ongoing maintenance backlog will erode quality and reliability of many assets, and bring higher costs for future asset maintenance and renewal.

When this will impact:



Where this will impact:



27. Opportunity

Low or non-capital better-use solutions to infrastructure problems could help to avoid or delay investment in expensive new or upgraded assets. These solutions could stretch public funding for infrastructure further, bringing productivity benefits for more users sooner.

When this will impact:



Where this will impact:



Market depth and skills

28. Challenge

Increased transparency of the infrastructure pipeline has not improved coordination on the timing and release of projects into the market, leading to some stretching of resources. A lack of coordinated procurement and delivery activity is resulting in constraints in key resources and skills.

When this will impact:



Where this will impact:



29. Challenge

The overall volume and project scale of infrastructure construction has created a heated, stretched construction market and reduced competition for projects. High risk projects are not achieving a desired level of competition during procurement. This may result in delivery being delayed or delivered by a higher risk, lower skilled contractor.

When this will impact:



Where this will impact:



30. Challenge

Despite meaningful progress in key jurisdictions and large agencies, the public sector is inadequately skilled and resourced to undertake a high volume of sophisticated procurement activity, including the oversight of projects during the delivery phase. Inadequate public sector procurement expertise can result in the taxpayer being exposed to inappropriate risks or costs, and compromising the capability of projects to achieve user outcomes.

When this will impact:



Where this will impact:



31. Challenge

There are skill constraints for key roles within the sector. The entrenched construction sector culture is limiting the sector's attractiveness to potential future employees.

When this will impact:



Where this will impact:



Procurement and contracting

32. Challenge

Truncated bidding timelines, unnecessary documentation requirements and under-resourced government project teams are leading to poor procurement and delivery outcomes. This results in higher levels of risk and uncertainty being priced into tenders. These costs are ultimately carried by the users through poor quality services or additional costs, or met through government reimbursements.

When this will impact:



Where this will impact:



33. Challenge

Community pressure can encourage premature project commitments or the acceleration of project delivery. Decision makers are often poorly resourced to respond to this pressure to arrive at an informed decision. Poorly planned, budgeted or scoped projects can result in project cost blow-outs or delays, as well as a failure to meet project objectives, resulting in long-term costs to users.

When this will impact:



Where this will impact:



Security, resilience and sustainability

34. Challenge

Anticipating and mitigating against ever-changing risks to infrastructure is becoming more difficult as assets and networks become more interdependent and complex. Australia lacks comprehensive resilience strategies for its assets and networks. A failure to appreciate and plan for risks to infrastructure may impose substantial financial, social and personal costs.

When this will impact:



Where this will impact:



35. Challenge

Climate and cyber risks are likely to pose considerable and growing threats to Australia's infrastructure.

Enhanced consideration of the risks to infrastructure can assist planning, design and operation of assets and networks, and can improve the resilience of services and reduce costs to future generations of users and taxpayers.

When this will impact:

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Where this will impact:



36. Opportunity

Australia could lead the world in developing and applying sustainability-enhancing approaches to its infrastructure. Taking the lead on sustainable infrastructure practices can benefit current and future generations of Australians, while providing opportunities for our businesses to share their expertise and innovation through exports and international development programs.

When this will impact:

0-5

5-10

10-15

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Where this will impact:



37. Challenge

Australia is at risk of not meeting its 2030 Paris Agreement commitments to reduce emissions by 26-28% below 2005 levels, in part driven by increases in transport, direct combustion and fugitive emissions. Without action in these sectors to reduce emissions, Australia risks becoming one of the highest carbon emitters per capita in the world.

When this will impact:

0-5

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Where this will impact:



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5

Transport

Transport is critical to our everyday lives. Our transport networks connect us to the opportunity to work, learn and socialise. They move the products we buy and use, from what we eat to what we wear. Our transport networks are vital to our collective economy and productivity, as well as to the quality and cost of living we experience as individuals.

For ease of analysis, this chapter treats passenger and freight transport sectors separately. In practice, the two are closely linked. Passengers and freight operators share road, rail, airport and port infrastructure.

Passenger transport connects people and places. This section discusses a broad range of modes, from active transport, such as walking and cycling, to private cars, public transport, aviation, cruise ships, ferries and emerging modes like rideshare.

Freight transport includes the complex array of supply chains that carry imported and locally produced goods for domestic consumption. This section also analyses

our export supply chains, with a particular consideration of agricultural and mineral exports and the key facilities, such as ports, intermodal terminals and airports, that service our international trade.

Our principal focus in this chapter is on the challenges and opportunities arising from a changing sector. The transport sector is undergoing a period of rapid transition, coinciding with the increasing congestion experienced by our cities as they undergo rapid growth.

Innovation in the transport sector has historically driven economic development and shaped the way we live. The impact of current and coming transport evolutions will be equally significant. Electrification, automation and rapid improvements in communications technology have the potential to transform the way people travel and our supply chains. However, these changes also present uncertainty for the transport sector and governments.







Passenger transport

5.1 Introduction



The state of the passenger transport sector

Australia's passenger transport networks serve an enormous variety of needs in a range of different environments, from congested and fast-growing cities to regional centres and remote communities. Given the demands placed on our networks, it is not surprising that the sector faces challenges.

Conditions of access to and the quality of our networks are not the same across different locations and for different people. This variation in service levels is the result of a necessary balance between providing appropriate transport access, and the financial and environmental trade-off of doing so in areas of varying density and demand.

The challenge of achieving a balance is compounded by a lack of transparency about why and how money is spent, particularly on the maintenance of our existing networks. This sits alongside the growth of emissions within the transport sector, which is the second largest emitter of greenhouse gas emissions in Australia.¹

Transport is also a major source of air pollution, one of the next major environmental challenges for our cities.²

Transport can be particularly difficult to access for lower income households, people with disability, older people, rural and remote communities, and people living on the outskirts of fast-growing cities. Our fast-growing cities suffer from congestion while our remote communities often have under-utilised and poorly-maintained assets.

However, there are also positive developments that will help in achieving this balance. The transport sector is in a state of rapid innovation, with advances in communications technology, user interfaces, transport operations technology, electric vehicles and, eventually, driverless cars offering customers unprecedented mobility and access to information, as well as potentially improving the environmental and safety performance of the sector.



Our passenger networks serve diverse needs

People's travel patterns vary depending on the time of day, purpose of trip, availability of transport options and distances to be travelled. While this section looks at high-level statistics regarding people's transport choices, such as whether they drive, walk or take public transport, it is important to remember that each mode of transport is one component of larger transport networks. In practice, people switch between modes, either during a single trip or from day to day, depending on what is most time and cost-effective for them.

Australia-wide, there were 433 billion passenger kilometres travelled in 2015-16, up 5.39% since 2010-11.³ Cars are overwhelmingly the dominant passenger transport mode, accounting for 279 billion (64.4%) of all passenger kilometres. Buses account for 4.99% and passenger rail services for 3.73% of passenger kilometres.⁴ There have been minor, year-on-year variations between modes, but no significant trend in mode shift over the period.

However, aggregated statistics only tell part of the story. People's travel habits are complicated, and patterns of demand vary depending on context. Public transport use is highest in our four largest cities, accounting for about 20% of journeys to work in the cities combined.⁵ Nationally, on average 9.87% of journeys to work were by public transport in 2016, up from 8.99% in 2011.⁶ Public transport is especially

important for accessing key employment centres. For example, over 71% of trips to and from Sydney CBD in peak periods are by public transport.

Journeys to work are also showing growth in the number of people driving or cycling. There has been a decline in the number of people travelling as a passenger in a car, in a taxi, in a truck and walking. The growth in single-occupant car journeys to work and decline in journeys as a passenger highlights reduced levels of vehicle occupancy, a catalyst for growing congestion.

Where high urban densities place people close to other services, and support attractive all-day public transport frequencies, there is less reliance on car use for non-work journey purposes also. Thus, in Sydney's inner city, 69% of all trips are undertaken using public or active transport.⁷ In Penrith, an outer-urban area of Sydney, by contrast, only 14% of trips of all purposes are undertaken by a mode other than car.⁸

While rates of use vary, walking and cycling are essential ways to travel. Whether people drive or catch public transport, most trips have a walking component. Over shorter distances, particularly in higher density-centres, walking is often the most common mode of transport. For example, in the centre of Melbourne's CBD (within the Hoddle Grid and Docklands), about 86% of all trips are made on foot,⁹ while 49% of all trips in Sydney's inner city are walk-only trips.¹⁰



While cycling is less widespread than walking, it comes with significant health and environmental benefits. However, there are also significant variations between areas, with cycling being most popular in the inner suburbs of our major cities. Australian cities have also been subject to the global phenomenon of the emergence of new active modes like e-scooters and bikeshare. The long-run popularity of these services remains to be seen, with several operators having had a short-lived presence in Australia's fast-growing and some smaller cities.

For long-distance intercity and regional trips, catching a flight is often the most practical solution. Australia has some of the busiest air routes in the world, with Sydney-Melbourne being the second busiest and Brisbane-Sydney the eighth.¹¹ Air travel is also important for rural and remote communities, ensuring they have access to major centres and key services.

The performance of our transport services is uneven

This Audit assesses the performance of our transport networks, including the services operated on these networks, through the multiple lenses of access, quality and cost. Australia's population is highly urbanised, with the majority of Australians residing in our fast-growing cities. These cities feature significant public transport networks providing relatively high quality services to people residing in the middle and inner suburbs.¹² However, access to transport networks and services is uneven across the country, with people who live in remote Australia or on the urban fringe, older people, those with disability, and those experiencing financial stresses being particularly disadvantaged.

Most of the challenges facing the level of access, quality and cost that our transport networks offer are consistent with the findings of the 2015 Audit.

Access conditions remain uneven, regional infrastructure is poorly maintained, and costs, while remaining stable, have impacted some groups more than others. The cost of road congestion and public transport crowding in our fast-growing cities is forecast to grow.

In contrast, in smaller cities and regional centres, as well as regional towns, rural communities and remote areas, Australians face a very different challenge to that of congestion. Australia's expansive geography and dispersed population mean transport networks are extensive but often poorly utilised, with maintenance resources spread thinly.

The cost of transport to end-users has generally remained stable or decreased slightly in real terms, albeit with variations by user group, and notwithstanding the substantial increased expenditure by some governments on operating, maintaining and expanding transport networks.

While some of the recurrent costs of driving have increased, motor vehicles have become cheaper. In the case of public transport, governments can be reluctant to increase public transport fares due to the wider benefits of these modes as well as the community unpopularity of ticket price rises.

However, there remain certain groups of Australians who are transport-disadvantaged in financial terms. Flights to rural and remote Australia can be prohibitively expensive, and people without access to public transport usually spend more of their personal and household budgets on operating vehicles.¹³

All Australian households continue to have to allocate a large share of their household infrastructure budget to transport costs.¹⁴

The cost of congestion is growing in our large cities

This Audit projects the total costs of road congestion and public transport crowding in Australia's large cities will be \$39.6 billion in 2031.

The majority of this cost is attributable to road congestion, \$38.8 billion per annum, while public transport crowding makes up \$837 million.

This Audit is the first time Infrastructure Australia has identified a cost of public transport crowding in our large cities.

This growth in congestion is in spite of significant investments in new transport infrastructure across our largest cities, particularly Sydney and Melbourne. Between the 2015 and 2019 Audits, the addition of 97 new projects to the Sydney transport network include substantial projects such as WestConnex, Sydney Metro Northwest, Sydney CBD and Parramatta Light Rail. Melbourne includes over 275 projects such as Melbourne Metro. Despite their scale, recent investments in transport infrastructure in our fast-growing cities is largely playing 'catch-up' rather providing additional capacity that will support substantial future growth.

While the costs of congestion are growing over time, Infrastructure Australia's forecasts of the rate of growth has reduced. The forecast cost of road congestion in 2031 is around \$14.5 billion lower than our forecast in the 2015 Audit.

The reduction is the result of a combination of changes to inputs, particularly lower population projections by the Australian Bureau of Statistics, some changes to assumptions regarding travel behaviour, improvements to the model, as well as capacity increases to transport infrastructure networks since 2015.

The most significant differences between Audits are in Greater Perth, where projections have been reduced by 19% reflecting the slower rates of growth following the mining boom. In addition, the other three less populated urban regions (the Brisbane, Adelaide and Canberra conurbations) have reduced congestion cost forecasts that reflect lower population projections and increased transport infrastructure investment.

However, Australia's two largest cities, Sydney and Melbourne, are predicted to have higher congestion costs in 2031 than previously forecast, at 6% and 15% respectively. This reflects significant growth in these two cities since the last Audit. Sydney and Melbourne are both on track to have over six million residents by 2031.

To a lesser degree, the downward estimates of costs are also a sign of the impact of major infrastructure investments that have been committed in our largest cities.

Our modelling of future congestion, as well as opportunities to improve strategic transport modelling, are considered in more detail in a technical paper to this Audit, *Urban Transport Crowding and Congestion*.¹⁵

Our transport networks must work harder to promote social inclusion

Transport is an enabler of daily life. It provides people with access to jobs, services and leisure. People's level of access to transport networks, and the opportunities these networks provide, often vary. Governments need to address this if they want to promote social inclusion.

This is particularly the case for Australians who are experiencing disadvantage, such as lower income households, people with disability, older people, rural and remote communities, and people living on the outskirts of fast-growing cities – or who experience multiple types of disadvantage.

For example, people living in our outer suburbs often have both lower average incomes than inner-city residents and lack access to public transport. Based on the 2016 Australian Census, the average household income in outer Sydney is approximately 75% of the average inner Sydney household income.¹⁶

For such people it is harder, and more expensive in proportion to family income, to reach employment opportunities.¹⁷ In Australia's five largest cities, 44% of outer-urban sector residents travel over 20 km to work, even though for 58% of these residents their employment is located in the same sector. In contrast, 76% of inner-urban sector residents live within 10 km of their workplace. Between the same two sectors, the proportion of people who live within walking distance of medium- or high-frequency AM peak public transport ranges from 96% of inner-urban residents down to 44% of outer-urban residents.¹⁸

The challenge of transport disadvantage is likely to expand in coming years due to the ageing of our population. Transport can be particularly difficult to access for people who are mobility impaired. Despite ongoing upgrades to our public transport networks, governments are almost certain to miss legislated deadlines to ensure public transport is accessible for people with disabilities.

Beyond our cities, access to transport networks is most limited for people who live in remote Australia. The survival of remote communities is dependent on road and air access. However, local governments often struggle to meet the cost of maintaining roads and airports, meaning remote Australians often lack access to key services, employment and consumer goods.¹⁹

The transport sector risks becoming financially and environmentally unsustainable

From a funding, maintenance and environmental perspective, our transport networks risk becoming unsustainable.

Australia is currently experiencing a transport infrastructure investment boom. Investment by the public sector is close to record levels, with governments focusing on building new roads and public transport projects.

However, Australia faces significant challenges not just in funding further new assets but in maintaining our existing and expanding asset base. At the heart of many of our transport funding problems is a weak link between usage and expenditure on the network.

These conditions are associated with a lack of transparency about why and how money is spent, particularly for maintaining our existing networks.

For roads, the problem of cost recovery has been exacerbated by a growing disparity between increasing traffic and the decreasing return of funds to governments from fuel excise due to improved vehicle efficiency. Fuel excise is the principal source of revenue associated with our road use. However, it is not tied to road or transport expenditure. In the 20 years to 2018, Australian vehicle kilometres travelled have risen, while excise revenue has decreased by 20%.²⁰ The prospect of the introduction of electric or alternative fuel vehicles could further accelerate that decline.

The gap between expenditure and income is as true of public transport as it is of roads, if not more so, with fare revenues not recovering the costs of operating or maintaining these modes. Many well-utilised transport networks cannot generate sufficient revenue in order to cover the costs of providing the service. The average public transport cost recovery from fares is low by international standards, averaging less than 30%.²¹ The cost recovery from public transport is low in comparison to cities like Toronto, Auckland and Wellington. For each dollar spent by a public transport user on a ticket, between three to ten times that amount needs to be spent by the taxpayer to subsidise the true cost of providing the service.²²

In 2016, investment in domestic transport networks represented approximately 1.3% of the nation's GDP.²³ As our population grows, and demand for transport increases and becomes more complicated, establishing effective, transparent and sustainable funding mechanisms for capital investment in and maintenance of our transport networks will be a key challenge. Despite strong support for user pays mechanisms for infrastructure, increases to direct user contributions can meet strong community resistance.²⁴

Transport also faces significant environmental challenges. The transport sector is the second largest emitter in Australia and its emissions are growing. Transport accounts for about 19% of Australia's emissions, with cars being the single largest contributor.²⁵ Transport has shown the most rapid growth in greenhouse gas emissions since 1990, growing by 62.9%, and is projected to grow by a further 12% by 2030.²⁶ Nevertheless, the transport sector is on the verge of significant technology change. Shared and electric vehicles have the capacity to substantially reduce transport emissions.

The passenger transport sector is in a state of rapid transition

A broad range of economic, social and demographic factors are contributing to rapid changes in Australian travel patterns and demand that are further compounding the challenges to the financial and environmental sustainability of our transport networks.

Technological innovation in particular is transforming the way transport is delivered, and is allowing governments to evolve from direct service providers to mobility facilitators. New service models such as on-demand, rideshare and carshare are already disrupting the transport market. The deregulation of point-to-point transport, such as Uber, in all Australian jurisdictions has likely been a precursor of further changes to come.

Public transport providers are starting to test the costs and potential benefits of on-demand transport products in helping to expand the reach of networks. This shift has been enabled by improvements in digital communications, which provide access to real time information and online booking. Ultimately, our transport networks could move towards a Mobility as a Service (MaaS) model, where people will be able to integrate their journey seamlessly across all forms of transport.

Australia's transport network will also soon be transformed by the most far-reaching changes in vehicle propulsion technology since the internal combustion engine entered mass production. Electric vehicles have the capacity to reduce transport costs, improve our air quality, reduce emissions, lower traffic noise and promote better public health outcomes. However, maximising these benefits will depend on policy intervention by governments. Under a

business-as-usual scenario electric vehicles might still only make up 6% of Australian passenger fleet sales in 2025. With policy support, this could be as high as 40%.²⁷

Connected vehicles are available on market and the number is growing rapidly.²⁸ While specific uses can vary considerably, many connected applications will require the provision of complementary roadside and emergency services infrastructure to accommodate their use.

Automated vehicles are currently being trialled in Australia and have the capacity to revolutionise all aspects of our travel, from the need to own a private car at all, to the safety and reliability of mass transit. It is currently uncertain how automated vehicles will integrate into the existing transport network, but it is clear that governments have an important role to play in shaping their use.

In this chapter

5.2 Changing urban travel patterns explores the role of economic and social developments in changing urban transport demand and travel patterns. We also investigate the changing role of government from delivering to facilitating transport services, and opportunities to better cater for customers' needs through technology and data analytics.

5.3 Technology and the future of passenger cars explores how the private vehicle market has evolved and will continue to change at a rapid rate. We discuss how sharing and connectivity between cars already exists, how the mass roll-out of electric vehicles will likely occur within the next 20 years and how automated and autonomous vehicles will grow in sophistication over that timeframe and beyond.

5.4 International, interstate and inter-regional connectivity investigates long-distance travel. Specifically, we look at the important economic contribution of international airports and the challenges they face. We also review transport challenges faced in regional and remote Australia.

5.5 Funding and maintaining our transport assets discusses the lack of consistency and transparency across Australia in the funding and maintenance of our transport assets. We also look at the potential for emerging third-party revenue streams.

5.6 Passenger transport sustainability and resilience discusses the large and growing emissions footprint of the passenger transport sector. We explore emerging technologies' capacity to reduce emissions. We also discuss transport network resilience and its role in safeguarding the liveability and economic strength of our communities.

5.7 Safety in the transport sector looks at recent trends in road safety and note we are unlikely to meet targeted reductions in fatalities. We also discuss vulnerable road users, such as cyclists and pedestrians, and investigate growing transport cybersecurity concerns.

5.8 Transport accessibility and equity explores the unevenness of access to transport and the opportunities it reaches, with a specific focus on those experiencing disadvantage. This includes lower income households, people with disability, older people, rural and remote communities, and people living on the outskirts of fast-growing cities.

Performance of the sector

Access

More than
1 in 2

people cannot walk to public transport in the outer suburbs ²⁹

Quality



More than
3 people
are killed each day on our roads ³⁰

Cost



Transport accounts for
65%
of the direct costs households pay for infrastructure ³¹

Cost

Electric vehicles

are forecast to reach price parity in 5-10 years ³²



55%

of Australians would like to see more investment in active transport infrastructure ³³

Access



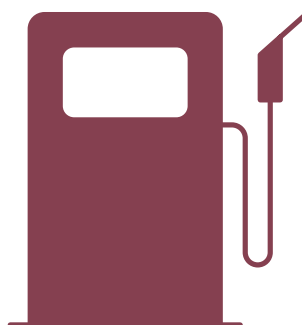
Access



44%

of people find it easy to access rideshare or on-demand transport services ³⁴

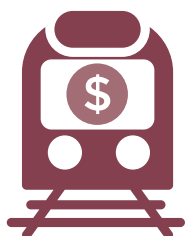
Cost



Average household
spends around \$200 per week
on owning and operating vehicles ³⁵

Cost

26%
of people think our rail services are expensive ³⁶



Quality

In 2031, public transport crowding will grow five times to cost Australia

\$837 million per year ³⁷



Scale of the sector

Asset

Australia's rail network is the **length of a return trip to London from Sydney** ³⁸



Asset



Australia's road network could wrap around the world **22 times** ³⁹

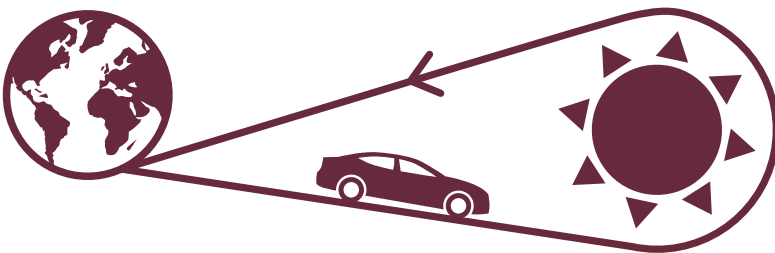
Customer



161 million people pass through our airports each year ⁴⁰

Customer

Australians drive the equivalent of **1,000 times from Earth to the Sun** every year ⁴¹



Industry

716 regulations stopping autonomous cars ⁴²

Industry



Highly automated vehicles first trialled **in Australia** in 2018 ⁴³

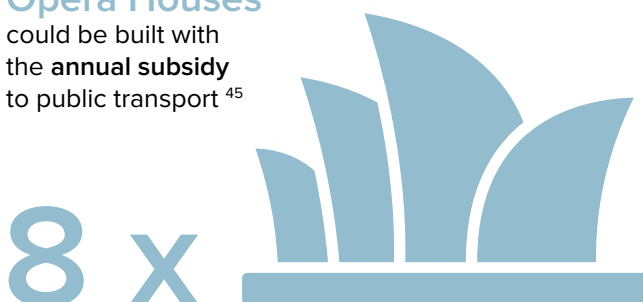
Asset



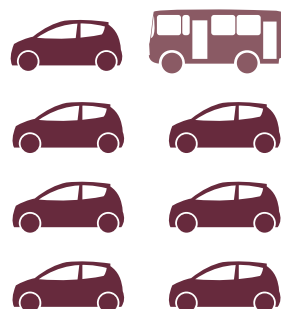
Cars typically sit idle **95% of the time** ⁴⁴

Industry

8 Sydney Opera Houses could be built with the **annual subsidy** to public transport ⁴⁵



Customer



1 in 10 trips to work are by public transport and **7 in 10** are by car ⁴⁶

5.2 Changing urban travel patterns

At a glance

This section explores how governments must cater to diverse travel patterns and higher demand in an increasingly urbanised Australia, and to avoid the high, and growing costs of congestion. Approaches include greenfield planning, non-radial transport grids and active travel modes such as walking and cycling.

We also look at the role of industry in supporting governments to better facilitate services instead of providing them directly. Approaches include new technologies, transport modes and use of data.

Our travel patterns are changing and becoming more diverse

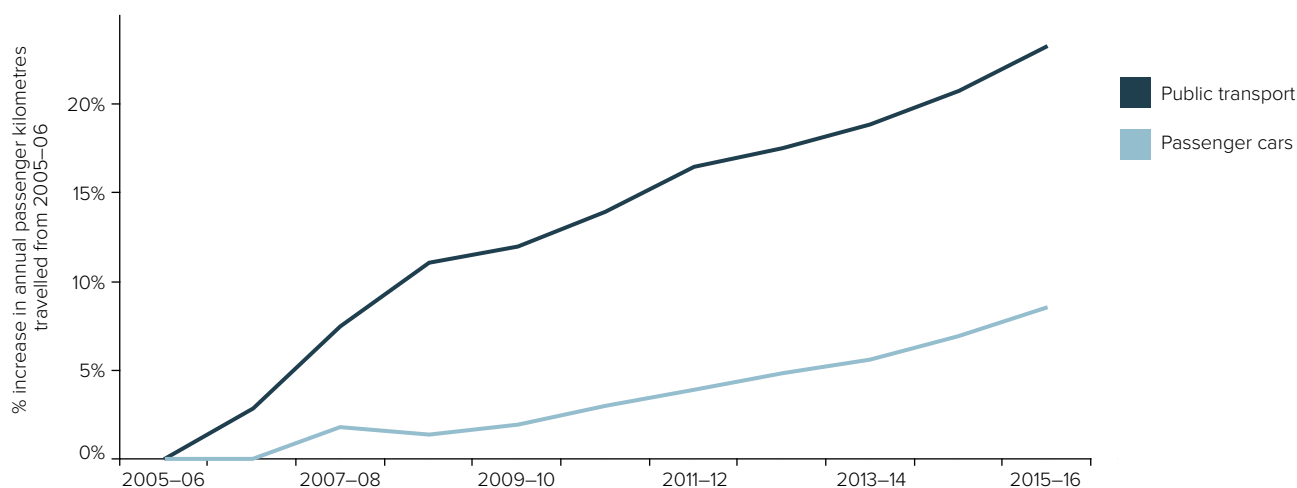
People's travel behaviour is becoming increasingly complicated. Traditionally, public transport planning has been geared towards catering for peak period trips into and out of major employment centres. Today's reality sees people travelling in large volumes outside the peaks, for multiple reasons, on a mixture of transport modes.

Simple population growth, as well as changing travel habits, is increasing the demand for urban public transport. While private vehicles are still the single most-used mode, public transport travel has grown by 24% over the past 10 years compared to only 8% for private vehicle travel (Figure 1).⁴⁷

Travel demands have always been much more complicated than the 'daily commute', and it is probable that non-work sources of demand have been insufficiently catered for over many years. Major trends are changing how people travel in our cities, making the passenger transport task larger, and more challenging, than it has been in the past.

These trends include:

- Urbanisation:** Australia's population is becoming more urbanised. Over the period from 2017 to 2047, Australia's population is projected to increase by over 11 million people. About 80% of this growth is expected to occur in our five largest cities (Sydney, Melbourne, Brisbane, Perth and Adelaide),⁴⁸ meaning the scale of the transport task in our cities will increase during weekdays and weekends.
- Ageing population:** The proportion of people aged over 65 is currently 15% and is projected to grow, by 2066, to 21% of a significantly larger overall population.⁴⁹ People's travel patterns change at different stages of their life. For example, retirees who no longer travel to work instead travel to more dispersed locations for leisure and access to services such as healthcare. Older people rely more on public transport when road safety requirements place limits on their driving, and are more likely to travel in off-peak periods than younger commuters.
- Flexible working arrangements:** The growing role of contract work and casual, part-time employment means journeys to work are increasingly being undertaken at different times of the day and on different days of the week. Technology is also enabling people to work anywhere, at any time, with almost one-third of all employees regularly working from home.⁵⁰
- Increasing off-peak travel:** One consequence of the breakdown in the traditional '9 to 5' is the spreading of travel away from peak periods. People in flexible working situations may undertake their commute in the middle of the day or the late evening, or travel during the week for non-work purposes like shopping or seeing friends. The latter types of journey are not associated with major employment centres well serviced by trunk public transport services, and typically end at a location where it is easier and cheaper to park. Hence, while some cities have seen an increase in the frequency of rail services during off-peak hours, these hold limited attraction for someone driving to a suburban shopping centre. Equally, more frequent off-peak bus services may still not be competitive with driving if they are not able to use peak-oriented bus priority facilities.
- Growing workforce participation:** Roles for women and men in paid and unpaid work are becoming more diverse. In particular, the travel patterns of dual-income families are becoming more complicated, with journeys to work often having to be timed to coincide with other commitments such as childcare and school drop-offs and pick-ups, further education, second jobs and shift work.
- Better access to real-time transport information:** Technology is central to our changing travel patterns. Smartphone apps in particular are changing the way customers interact with public transport, providing real time information to help people to reduce their wait time, avoid service delays, and make better travel choices.

Figure 1: Travel is growing, particularly for public transport

Source: Bureau of Infrastructure, Transport and Regional Economics (2018)⁵³

Urban transport is becoming more crowded and congested

With growing populations that are becoming more urbanised and more diverse in their travel patterns, the pressure on our transport networks is significant.

Infrastructure Australia has calculated the cost of the growing demand for urban transport in terms of crowding and congestion. The total cost of road congestion and public transport crowding was estimated to be \$19.0 billion in 2016 and is expected to more than double to \$39.6 billion by 2031, with road congestion making up \$38.8 billion (Table 1).

Road congestion accounts for most of these costs. This is because private vehicles are still the dominant mode choice and road congestion is increasingly an all-day, everyday problem.

While crowding on public transport is mostly a peak period problem, this is rapidly growing as patronage increases and peak periods become longer. Crowding is especially evident on urban rail services as commuters look to avail themselves of the relatively good speed and reliability of the train for longer-distance travel, compared with road travel by car or by a bus operating in mixed traffic. The Sydney Trains network is a good example of how rapid growth in demand is causing overcrowding at stations and on trains, with impacts on service reliability and travel times.⁵¹

Infrastructure Australia also undertook costs of congestion modelling in the 2015 Audit. Overall, the projected cost of congestion for roads (public transport was not included in the 2015 calculations) is now about \$14.5 billion lower. This is largely because of a significant reduction in projected population growth in Perth. In the 2015 Audit, ABS population projections for Perth had been developed at the height of the mining boom. With that city's economy now growing at a much slower rate, population projections have been adjusted accordingly.

The forecast cost of congestion also decreases for Brisbane, the Gold Coast and Sunshine Coast, the ACT and Queanbeyan, and Greater Adelaide. For the first two conurbations, population forecasts have decreased by 2% and 8% respectively, when compared to the 2015 Audit. For Adelaide, although population forecasts have remained stable, modelling outcomes now point towards a different spread of congestion impacts.⁵²

In contrast, for our two largest cities, Sydney and Melbourne, the projected costs of congestion are now greater. This reflects the substantial growth in these two cities since the last Audit, their growing role in the national economy, and the forecast growing gap between travel demand and the supply of new roads and public transport infrastructure.

More detail on Infrastructure Australia's transport modelling can be found in the Australian Infrastructure Audit Supplementary Report, *Urban Transport Crowding and Congestion*, as well as Supplementary Reports examining the congestion impact on each of the six examined regions.

Table 1: Costs of road congestion and public transport crowding are forecasted to double from 2016 to 2031

Model area	Cost	2016 (\$ millions)	2031 (\$ millions)	2031 (\$ millions) from 2015 Audit
Sydney, the Hunter and Illawarra	Public transport crowding	68	223	N/A
	Road congestion	8,038	15,693	14,790
Melbourne and Geelong	Public transport crowding	75	352	N/A
	Road congestion	5,485	10,379	9,006
Brisbane, the Gold Coast and Sunshine Coast	Public transport crowding	14	90	N/A
	Road congestion	2,084	5,969	9,206
Greater Perth	Public transport crowding	17	159	N/A
	Road congestion	1,525	3,620	15,865
Greater Adelaide	Public transport crowding	1	4	N/A
	Road congestion	1,444	2,619	3,747
ACT and Queanbeyan	Public transport crowding	1	8	N/A
	Road congestion	289	504	703
Total	Public transport crowding	175	837	N/A
	Road congestion	18,865	38,784	53,317
	Congestion and crowding	19,040	39,621	N/A

Source: Infrastructure Australia (2019)⁵⁴

38. Challenge

Urban travel patterns are becoming increasingly complex, driven by economic, social, demographic and technological changes. There is a risk of growing divergence between the way our networks are planned and designed, and the needs of customers. Failure to cater for changing patterns of travel could contribute to growing congestion in our fast-growing cities.

**When this
will impact:**



**Where this
will impact:**





Land-use planning decisions impact on travel patterns in our cities

Travel patterns vary across each city, meaning transport planners cannot adopt a ‘one size fits all’ approach. Land use is a particularly important factor in how people travel. For example, the transport needs of people travelling to a CBD in the AM peak will be very different to parents taking their kids to Saturday morning sport in the outer suburbs.

Activity centres and higher-density areas require a mix of infrastructure and policy solutions, such as high-capacity public transport, robust parking policies and prioritisation for pedestrians and cyclists. In contrast, lower-density outer suburbs tend to be more reliant on private vehicles, but still require carefully planned public and on-demand transport services that balance attractive service levels with costs to government.

The rapid growth where existing suburbs have redeveloped at higher densities at the same time as greenfield land has been released for housing on the urban fringe, the rapid growth of our cities has added to the complex demands and pressures on our transport networks. There has been significant urban consolidation in established parts of our largest cities, particularly Sydney and Melbourne, which has increased population densities substantially in

inner city areas. Our cities also continue to expand outwards, with State governments reporting that greenfield development rates account for about 20% of growth in Sydney, 30% in Melbourne and as much as 70% in Perth.⁵⁵

The growth and complexity of our cities make them vibrant places to live and work, but also present challenges to planners. In some parts of our cities, infrastructure has not kept pace with population growth and development. Coordination across portfolios has been particularly problematic, meaning some growing communities have been left without sufficient access to key services.⁵⁶

Governments and transport operators face major challenges in ensuring legacy networks and services remain fit for purpose and that new infrastructure is provided for greenfield and brownfield development. Aligning the delivery of transport infrastructure with housing, employment growth and other key infrastructure that influences the demand for transport, such as schools, universities and hospitals, is a particularly complicated task that requires whole-of-government coordination. In some jurisdictions this challenge is starting to be addressed through the establishment of governance models that look beyond traditional siloes, including the Greater Sydney Commission, although further work is needed in this area.

39. Challenge

Rapidly changing land use and development can place pressure on urban transport networks. Densification in our largest cities places pressure on legacy networks, while greenfield development requires new infrastructure and services. Failure to coordinate land use and transport planning can contribute to congestion and crowding in some areas, or a lack of adequate services in others.

When this
will impact:

0-5

5-10

10-15

15+

Where this
will impact:



Changing travel demand creates challenges for public transport network design

Our legacy public transport networks are largely radial. Major public transport routes are typically designed to carry people into a city's central business district from the suburbs. This is because our public transport networks have expanded progressively with our cities, extending from a central, dense and pre-motor vehicle core to connect to lower-density suburbs from which commuters have traditionally headed to the city.

The practical consequence of this is that public transport routes converge as they get closer to a CBD, meaning inner suburbs are serviced by a denser network of routes and stops than outer suburbs. Even if services in these inner areas operate less frequently in off-peak than peak hours, this has a lower impact on residents of high-density areas where non-work destinations such as shops, cafés and leisure facilities are within walking or cycling distance.

In contrast, public transport in our outer suburbs is typically characterised by longer travel times to major employment centres, lower levels of walking accessibility to public transport stops (and to other, non-work-related destinations), lower service frequencies and a shorter span of operating hours.⁵⁷ In this situation, even if public transport is the most viable choice for commuting, its use may not be realistic for other journey purposes, especially during the late evening or at the weekend.

Work-related travel makes up only about a small proportion of trips, and even fewer on weekends –in Melbourne for instance, they comprise 26% of weekday trips and 6% of trips on weekends

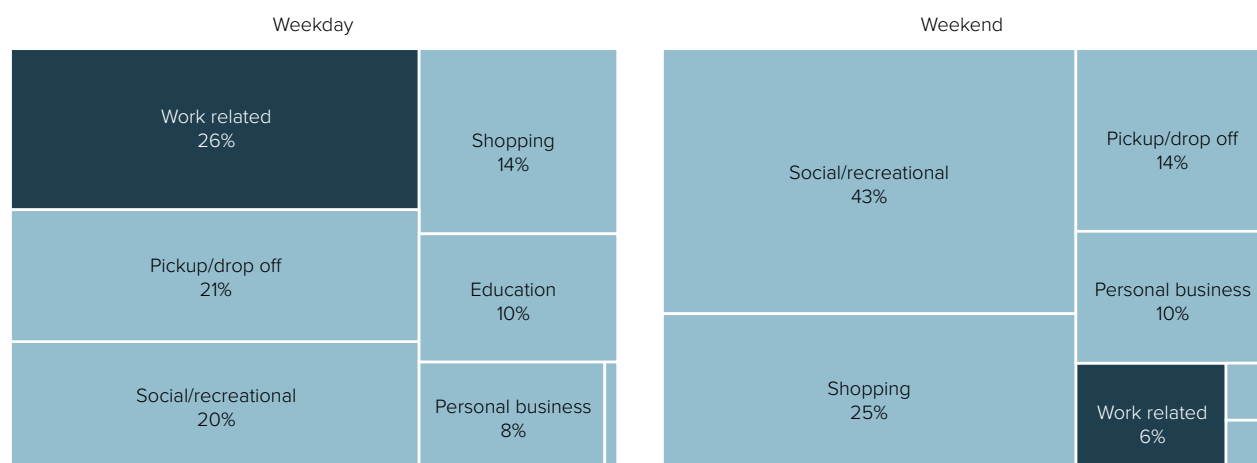
(Figure 2).⁵⁸ In addition, although our CBDs are important and dense employment centres, they account for a minority of all the jobs on offer across the larger conurbation in which they are located. For example, only about 33% of Melbourne's jobs are located in its inner city and CBD.⁵⁹

Against this background the comparative inflexibility of public transport is a key reason why it struggles to compete with private vehicles. In our five largest cities, for example, about 19% of people catch public transport to work. Cars can take people between any origin and destination in a city. In contrast, our radial public transport networks serve a small number of destinations very well, such as CBDs and major employment centres, while large parts of each city, particularly in middle and outer suburbs, have relatively low service levels.⁶¹

The challenge for governments is to cater for a broader range of trips, including non-radial journeys and trips that are outside peak hours. This is particularly important in the context of changing patterns of demand, such as greater workplace flexibility, an ageing population and growing participation rates, which are all contributing to more varied and complicated travel patterns.

Some jurisdictions have identified the development of new, non-radial links. However, some of these projects may carry significant costs due to their delivery within existing urban areas. As a shorter-term solution, governments have started to encourage people to interchange between services as part of a single public transport journey. Each interchange represents an opportunity for a passenger to change their direction of travel and opens a greater diversity of potential destinations.

Figure 2: 26% of weekday trips and 6% of weekend trips in Melbourne are work related



Note: Values show proportion of trips for an average day in Melbourne. This is drawn from the 2014-16 Victorian Integrated Survey of Travel and Activity, which collects data across the two years.

Source: Victoria Government Department of Transport (2016)⁶⁰



This is the principle by which connected public transport networks operate in cities and regional centres internationally. In Australian cities its application is being made possible by the availability of electronic ticketing data, which give planners rich information on travel patterns across a city's public transport network, at different times of the day, and can inform adjustments to peak and off-peak service patterns.

Well-designed, integrated networks that encourage interchanging are generally characterised by:

- Service hierarchies and suitable transport modes for each route.
- A 'grid' or 'connected' structure that ensures orbital routes interchange with radial routes, meaning

passengers have the opportunity to change between services.

- High service frequencies and/or coordinated services that minimise the waiting time for transferring passengers.
- Well-designed interchanges that allow passengers to easily and quickly change between services.
- Interchanges, stations and stops that are easily accessible by active transport (walking and cycling) and include storage for bicycles and e-bikes.
- Integrated ticketing and fare regimes, which reduce the need for customers to buy separate tickets, and minimise any 'interchange penalty' (the requirement to pay for separate trips as part of a single journey) in the cost of the ticket.

40. Challenge

Our radial public transport networks are inflexible and have varied levels of service and relatively low mode shares. Unless our public transport networks are designed to cater for a broader range of trips, they will not meet the changing needs of a growing number of customers.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Metropolitan strategic transport models have limitations

Transport models are crucial in helping planners better understand the impact of policy and project decisions. The type and scale of transport models vary widely, from relatively targeted models used to examine changes resulting from individual projects, to city-wide, strategic models like those used in our Audit to predict likely future conditions across metropolitan regions.

Modelling a metropolitan region requires a wide range of assumptions to be made about how people will travel in the future, what infrastructure will exist and where and how people will choose to live and work. The models then give us a good picture of likely future challenges, but offer just one possible view of the future.

Some commonly understood limitations of metropolitan strategic models are that they find it difficult to account for:

- Different travel patterns on weekends and over holiday periods.
- The possibility that people will choose to live differently in the future and that population or jobs growth will occur in unforeseen places. The modelling in this Audit is based on the latest available State and Territory projections, to be as consistent as possible with other planning models.
- The possibility that people's travel behaviours will change in the future and they will choose different lifestyles to today's population. For example, people may choose to travel at different times of the day to avoid congestion, travel more on weekends or choose to use different modes. The modelling in this Audit considers a generic 'typical' day, and then looks at the typical peak periods within that day.
- The implications of technological changes, like automated vehicles. The wider impacts of these changes are being explored by the Australian Government and by the broader global community, and we anticipate having a much

clearer understanding of this over the next five years. Due to significant uncertainty about the pace and impact of technological change, the Audit modelling assumes no change in technology.

- The benefits of small and/or non-road projects. Under a previous 'predict and provide' paradigm, models were geared towards highlighting the advantages of large projects, and especially large road construction projects whose value is principally derived from the mass aggregation of many small future travel time savings. As a consequence, more modest investments returning proportionately high benefits targeted at existing transport problems have been relatively excluded from consideration.
- Outcomes for outer-urban and peri-urban areas, because the travel zones in these areas are larger, meaning estimated travel times are less accurate.

Identifying the best solutions to the challenges raised in this Audit will require further more detailed analysis and the exploration of a wide range of possible solutions, using new modelling techniques. This process is explained in detail in the *Infrastructure Australia Assessment Framework*.⁶²

41. Opportunity

New technology and data sets are increasingly available in the transport sector, that can be used for planning and service delivery. Better information allows governments and operators to better understand and cater for customers' transport needs and expectations.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:





Active transport is at the heart of an integrated transport network

An integrated transport network has active transport at its core. Walking and cycling play a critical role in our transport networks, particularly for shorter trips and for the first or last kilometre in the journey between people's origins and destinations. For public transport journeys this can mean the connection between the trunk mass transit corridor and home or work.

This means that in order to cater for people's entire journey, from their front door to their final destination, planners have to consider and promote active transport as a critical component of the transport network.

Walking is naturally the most common way for people to move.⁶³ Most journeys at least start or end with a walking component, whether people are walking to their local railway station or from a car park to their office. For shorter trips, particularly in high-density centres, walking is often the most popular form of transport. For example, in Melbourne's CBD about 86% of all trips are on foot.⁶⁴

Cycling plays a different and smaller role than walking, but is also important. Cycling can be a relatively quick form of transport, particularly for shorter trips. In dense parts of our cities, cycling often takes less time than driving for a journey below 5 km.⁶⁵ This means cycling is normally more competitive in our inner-urban areas than the outer suburbs. For example, in Greater Melbourne an average of 1.8% of trips are by bike, but in more central local government areas, such as Yarra and Port Phillip, cycling is closer to 7% of trips.⁶⁶

Active transport also has obvious environmental and health benefits. It produces no direct emissions and helps to improve people's fitness and wellbeing. The benefits of active transport have been recognised by the World Health Organisation, which notes it is key to reducing the 3 million deaths globally each year that are caused by physical inactivity.⁶⁷ New technology, such as electrification for bikes and scooters, is providing opportunities for broader groups of people to access the benefits of active transport.

However, despite its benefits, active transport remains a challenge for Australian policymakers. Australia sees relatively low rates of active transport use compared to European countries. About 5% of Australia's journey-to-work trips are undertaken solely by active transport. Over 30% of trips in Sweden, Germany and Denmark, and over 50% in the Netherlands, are by walking or cycling.⁶⁸

Active transport has markedly declined among certain parts of the community over the 50-year post-war period during which the level of vehicle ownership increased from one car for every six to seven Australians, to one for less than every two Australians.⁶⁹ The number of Australian children regularly walking or cycling to school has halved in the last 40 years, with less than one-third now regularly using active transport to get to school.⁷⁰

There are numerous potential causes for Australia's active transport shortfall. In particular, pedestrians and cyclists are especially vulnerable to road crashes. Additionally, beyond the inner areas of our larger cities, there are generally long distances to be covered between people's homes and their potential destinations, such as local shops or public transport stops.



However, long distances are not the only reason, as many short trips are undertaken by car in Australia. For example, there are over two million car trips every day in Sydney that are less than 2km in length.⁷¹

Other commonly cited barriers to walking and cycling refer to insufficient infrastructure. About 70% of people in New South Wales say they would cycle more if they had access to separated bicycle lanes.⁷² Similarly, surveys carried out in Western Australia show that more people would walk if better footpaths were provided.⁷³ Problematically, however, it is the densely settled areas where walking and cycling would be most feasible in land use terms that are the most challenging places in which to find the space to widen a footpath or excise a traffic lane for a cycleway.

From a transport planning perspective, a key challenge is ensuring that our active transport networks are integrated with public transport. Many of our public transport facilities are not easily accessible, meaning the mobility-impaired and older people are less likely to walk to their local station or bus stop. In addition, people may feel unsafe, particularly at night, when they walk or cycle to public transport.⁷⁴ Finally, cyclists need storage facilities at public transport stations and stops.

While there are likely multiple reasons for Australia's comparatively low levels of walking and cycling, it is clear there is an opportunity to improve and better integrate active transport with the rest of our networks.

42. Challenge

Australia has relatively low rates of active transport, driven by a range of issues including low densities and long distances, insufficient infrastructure and safety concerns. Without action, our transport networks and travel patterns will remain poorly integrated and sustainability improvements will be limited.

**When this
will impact:**

0-5

5-10

10-15

15+

**Where this
will impact:**



5.3 Technology and the future of passenger cars

At a glance

Technology is disrupting the private vehicle market, as users embrace the most efficient and affordable methods of transport. Key changes include:

- The growing sharing economy is making car ownership less attractive.
- New technology connects cars to the internet and their physical surroundings.
- Electric and autonomous cars will soon be available.

This section looks at the potential benefits of these changes, and the regulatory barriers they face.

Technology is disrupting the private vehicle market

Technological change has always gone hand-in-hand with the automotive sector and car travel. Most users have experienced change through incremental in-car improvements in safety, fuel efficiency, audio visual, wayfinding technology and satellite navigation systems. However, over the next 15 years, the pace of change will dramatically increase. Technology and digital connectivity will fundamentally change how customers interact with transport infrastructure and how operators deliver transport services.

The cars of the future will be:

- **Shared:** Cars are already becoming part of the shared economy.
- **Connected:** Cars are increasingly connected to the physical environment they occupy, including adjacent vehicles and infrastructure.
- **Electric:** The shift away from the internal combustion engine is under way, and within 10-15 years it is possible that as many as one in three passenger vehicles sold in Australia could be electric.
- **Autonomous:** Within the next couple of generations many users may be able to get where they need to go without a driver.

Each technology presents a large amount of uncertainty, risk and reward. Depending on their implementation, each could have positive or negative effects on consumer quality, cost and access outcomes. What is clear is that there will be profound impacts on the way we travel and how much we pay to do so.

Governments and industry need to be on the front foot to ensure that they keep pace with the speed of technological development and the influence of its advocates. Without planning, the benefits on offer to consumers and taxpayers could be lost.

Our vehicles are becoming part of the shared economy

Mobility as a Service accounts for door-to-door journeys

Mobility as a Service (MaaS) represents a shift away from personally-owned transport towards mobility solutions that are consumed as a service, through either 'pay-as-you-go' or periodic subscription business models. MaaS aims to allow the user to purchase from a variety of mobility options to best suit their needs, using a digital application, such as a smartphone app. A well-designed and implemented MaaS scheme can save consumers costs and provide an alternative to personal car ownership.

Under the ideal MaaS model, travellers access real time information on how to get to their destination, by whichever mode or combination of modes is most efficient and affordable, and then use the same interface to book and access preferred services. MaaS aims to bring together private and public operators to allow seamless travel and to better match supply to demand.

As such, MaaS could be a useful tool for public transport providers that are increasingly looking towards on-demand and multimodal transport solutions to help expand the reach of their public transport networks, and fulfil the first and last mile transport needs of passengers. The impacts of MaaS could be accelerated and multiplied when coupled with other emerging technologies, particularly automated vehicles.

Elements of MaaS already exist in Australia, but no jurisdiction offers a single common framework within which a range of private sector actors can work together to coordinate all multimodal travel choices. Awareness of the potential benefits of MaaS is increasing. The Queensland Government has established a MaaS project office and government bodies have called for consideration of MaaS in future transport planning.⁷⁵

The shared economy is here and growing. Its growth has been enabled by advances in digital connectivity, the ubiquity of smartphones and changing customer expectations. The shared economy is expanding the range, availability and penetration of car-based passenger services through new platforms for ridesharing (e.g. Uber, Lyft, Ola), carsharing (for example, GoGet, Green Share Car, Flexicar) and peer-to-peer carsharing (e.g. Car Next Door, DriveMyCar). More recently sharing has also extended to other parts of the car industry, such as car parking and accessories, like trailers and caravans.

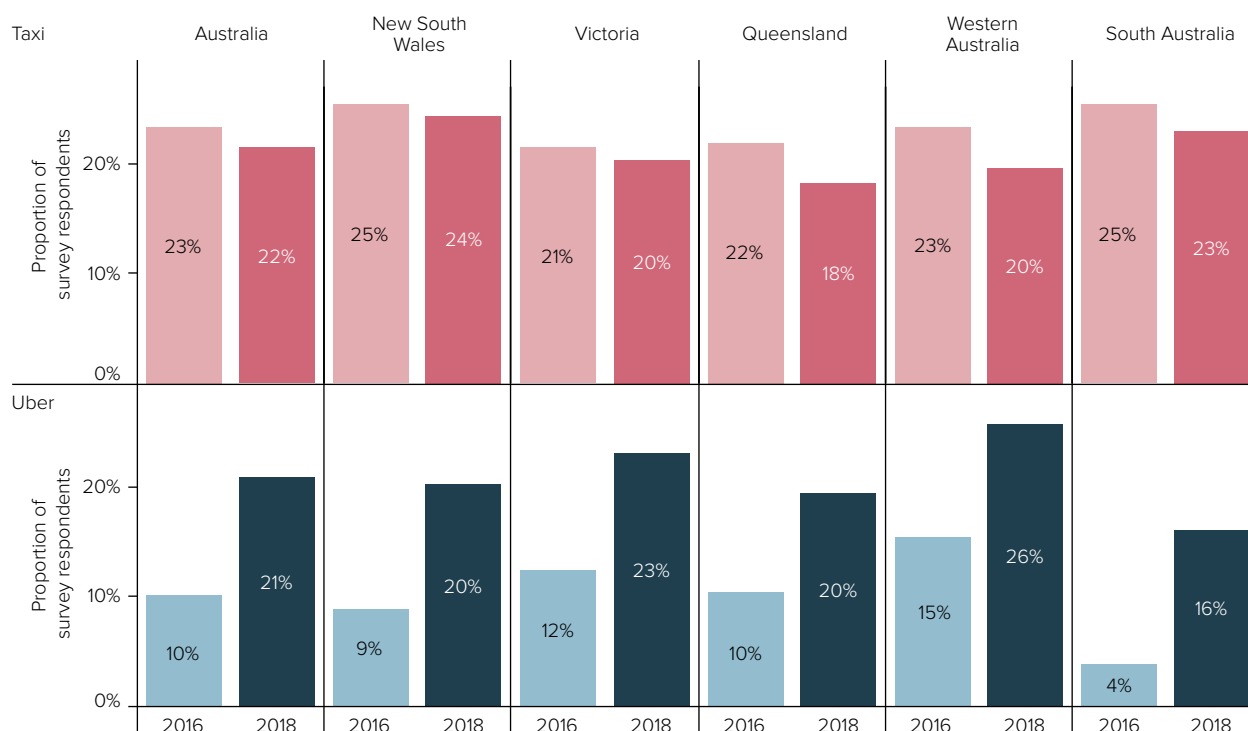
The shared economy has resulted in major changes for transport users, particularly in our cities. Where available, it can reduce transport costs, increase ride quality through the offer of personalised services, improve convenience, and reduce the need to own a private vehicle.

Cars, which were once an asset purchased for private and often single-occupant use, have the opportunity to be shared or hired, earning the owner a return. Peer-to-peer carsharing combines aspects of the

rideshare economy and traditional carsharing to provide more choice around vehicle types, rental periods and charges.

Peer-to-peer carsharing has allowed car owners to put their vehicle to greater use. This is relevant, as cars typically sit idle for 95% of the day and cost the average Australian family \$22,000 per year, or 17% of average household income.⁷⁶ According to Car Next Door, car owners can make between \$3,500 and \$10,000 per annum by renting out their unused vehicle.⁷⁷ This gives car owners a chance to monetise their assets while increasing car availability to other users. In Australia, there are 16 carshare providers, which collectively generated \$69.7 million in annual revenue in 2015-16.⁷⁸

The ridesharing economy is even more prevalent. Ridesharing service Uber was used by one in five Australians within the three months to December 2018, double the number in the same period two years prior (Figure 3).⁷⁹ This increase coincided with a reduction in taxi journeys of 1.9%.

Figure 3: Uber use is rising rapidly, while taxi use is declining

Note: Respondents were asked whether they had travelled by Uber or taxi in an average three months to December 2016 and December 2018.

Source: Roy Morgan (2018)⁸⁰

However these services have been to date largely absent from regional centres, Uber is expanding to smaller regions including Bathurst, Tamworth, Rockhampton, Gladstone, Bundaberg, Warrnambool and Horsham.⁸¹

The growth of affordable and convenient sharing options continues to make the prospect of owning a car at all less attractive for more Australians. Whether it is due to the increasing availability of these transport choices or for other reasons, recent trends suggest younger Australians see car ownership as a choice rather than a necessity. Licence rates for young Victorian adults decreased by 18% from 2001 to 2016, with 18-year-olds having the lowest licensing rate on record (36%).⁸² Small declines are also being seen in New South Wales.⁸³

Nevertheless, car ownership remains high in Australia.⁸⁴ The opportunity for reduced car ownership may be limited to inner city areas, where access to public transport is better and the take up of ride and carsharing is most prevalent.⁸⁵ For now there are many diverging views of the impacts of carsharing and ridesharing on the transport network.

Table 2 highlights the uncertainty facing governments, in terms of their preparedness to deal with a wide range of potential impacts from new technology on the transport sector.

Where a rideshare is used for, say, the return leg from a traditional public transport trip, in place of driving oneself both ways, the total number of single-occupant private car trips could be reduced, with benefits for congestion. Multi-occupancy rideshare services, that allow multiple customers to share the vehicle with other customers in return for a cheaper fare, could also reduce congestion. Carsharing in place of personal car ownership could reduce the demand for parking in dense urban areas.

However, carsharing and ridesharing can also add to road congestion. Studies of large cities including New York and San Francisco have found evidence of the growth in ridesharing contributing to congestion by tempting customers away from more space-efficient public transport services, and through drivers cruising the road network between fares, or competing with buses and other vehicles for scarce kerb space when picking up and dropping off customers.⁸⁶ In these circumstances, the viability, cost recovery and, ultimately, frequency of traditional public transport services can be compromised, leaving government as the service provider of last resort for users without the financial resources to access a personalised Mobility as a Service product.

Table 2: Transport sharing options have uncertain impacts on private vehicle use

Product	How could this product lead to an increase in vehicle kilometres travelled?	How could this product lead to a decrease in vehicle kilometres travelled?	Potential vehicle kilometres travelled change
Carsharing	Personal car use becomes more affordable for non-car owners. '8% of users would drive more'. ⁸⁷	Existing car owners give up ownership. '35% of users would drive less', based on survey (n = 6,167) of car2go members in five US cities. ⁸⁸	Reduction in vehicle kilometres travelled. 'Potential for 11% reduction per average user'. ⁸⁹
Ridesharing	Ridesharing promotes car travel as an alternative to traditional public transport use.	Ridesharing in larger vehicles could displace multiple vehicle trips.	Ridesharing to common CBD destinations would likely displace public transport use, based on survey results (n = 2,501) from investigation of Melbourne CBD car pooling scheme. ⁹⁰
Multimodal apps (for example, Whim and SMILE)	Provides easy and attractively priced access to rideshare and carshare.	Provides easier access to public transport, bikesharing and walking.	Likely to have marginally negative impacts on travel demand and vehicle kilometres travelled. In Vienna, the SMILE pilot saw a 21% reduction in private car usage, but only a small proportion of the total fleet was affected. ⁹¹
Ride sourcing (promoting access to ridesharing through multimodal apps)	Reduced cost, differentiated service and brand repositioning attract public transport users to travel by rideshare.	Existing car owners with poor access to trunk public transport become able to use public transport due to availability of attractive first and last kilometre solutions.	Analysis indicates total trips can increase by 0.05%.

Source: Deloitte (2017)⁹²

43. Challenge

The accessibility and affordability of ride and carsharing could decrease demand for public transport. In these circumstances, demand shifts from space efficient public transport back to cars, potentially increasing congestion.

When this will impact:



Where this will impact:



Cars are increasingly connected to the world around them

The number of devices connected to the internet is 20 to 30 billion worldwide, and cars are becoming a big part of this story.⁹³ Some cars already send up to 25 gigabytes of data to the cloud every hour.⁹⁴ The amount of data exchanged will increase massively as cars become more autonomous.⁹⁵

Cooperative vehicles already running on Australian roads use digital technology and the internet to communicate wirelessly with other vehicles, roadside infrastructure, mobile phones and transport management systems, including traffic signals. Drawing on these data sources, vehicles provide audible and visual prompts to assist drivers and warn them about upcoming traffic accidents, congestion and quicker routes.⁹⁶ These technological advancements are improving the quality, safety, efficiency and cost of users' journeys. A recent United States study on the impact of smart technology on the national car fleet calculated national annual savings of US\$6.2 billion from fuel efficiency gains alone.⁹⁷

The full benefits of cooperative vehicles that are capable of even greater autonomy, up to and including driverless operations, will only be realised

when enabling physical infrastructure and operating systems are in place, supported by appropriate regulations. Policy-makers need to be proactive to keep pace with technological development. If they are not, users will not access the full benefits of increased connectivity.

Governments have made progress towards enabling more connectivity between vehicles and the surrounding environment. Queensland has been at the forefront of innovative trials to enable the use of cooperative vehicles. States and territories across Australia have also been rolling out intelligent transport systems along motorways under the Managed Motorway Initiative. Most jurisdictions are installing elements of electronic message boards, tidal flow systems, vehicle detection sensors, smarter traffic lights, variable speed limit signs and CCTV cameras on motorways and selected arterial roads, and integrating these into operating systems that monitor traffic conditions,⁹⁸ manage congestion and respond to incidents in real time.⁹⁹ However integration of these systems remains piecemeal.

The growth and improvement of cooperative intelligent transport systems will see the benefits already achieved on such routes expand across wider road networks.

Queensland is preparing for cooperative and automated vehicles

The Queensland Department of Transport and Main Roads' Cooperative and Automated Vehicle Initiative aims to validate the effectiveness of cooperative and automated vehicles as part of Australia's largest on-road trial of vehicles and infrastructure. The project will begin with a nine-month on-road trial in Ipswich in 2019.

500 private and fleet vehicles retrofitted with cooperative intelligent transport systems technology will be involved in the pilot. These devices will enable vehicles to 'talk' to one

another and to roadside infrastructure. The devices will also provide safety warnings about a range of conditions, such as pedestrians crossing at signalised intersections, hazards on the road and congestion ahead.

Outside Queensland, automated vehicles trials using small shuttles are underway on a mix of private land and the public road estate. These trials have the opportunity to inform regulation and to increase community awareness of change.

44. Opportunity

Connected vehicles can reduce accidents, improve traffic flow and reduce costs for drivers. Leveraging this new technology could improve access, quality and cost outcomes for users.

When this will impact:



Where this will impact:



Within 10-15 years up to a third of cars sold could be electric

Electric vehicles will challenge internal combustion vehicles' dominance over the Australian automotive industry. Currently consumers wanting to buy an electric vehicle face several barriers, namely range anxiety, a lack of vehicle choice and a large upfront price. Consequently, electric vehicles only comprise 0.2% of our current fleet, which is somewhat lower than in other comparable countries, such as the United States, New Zealand and Germany.¹⁰⁰ However, this low level of uptake is not indicative of where the electric vehicle market is heading. As the barriers to electric vehicle adoption fall, uptake rates will rise.

The creation of a mass market for electric vehicles will be driven in large part by the rapid reduction in electric vehicle costs relative to internal combustion engine vehicles. The price of a lithium-ion battery, which makes up over half of the cost of an electric vehicle, is falling. Many analysts, such as Bloomberg New Energy Finance, predict price parity could occur as early as 2025.¹⁰¹ Alongside this, battery capacity and life are increasing, allowing longer trips on a single charge, more charging stations are being

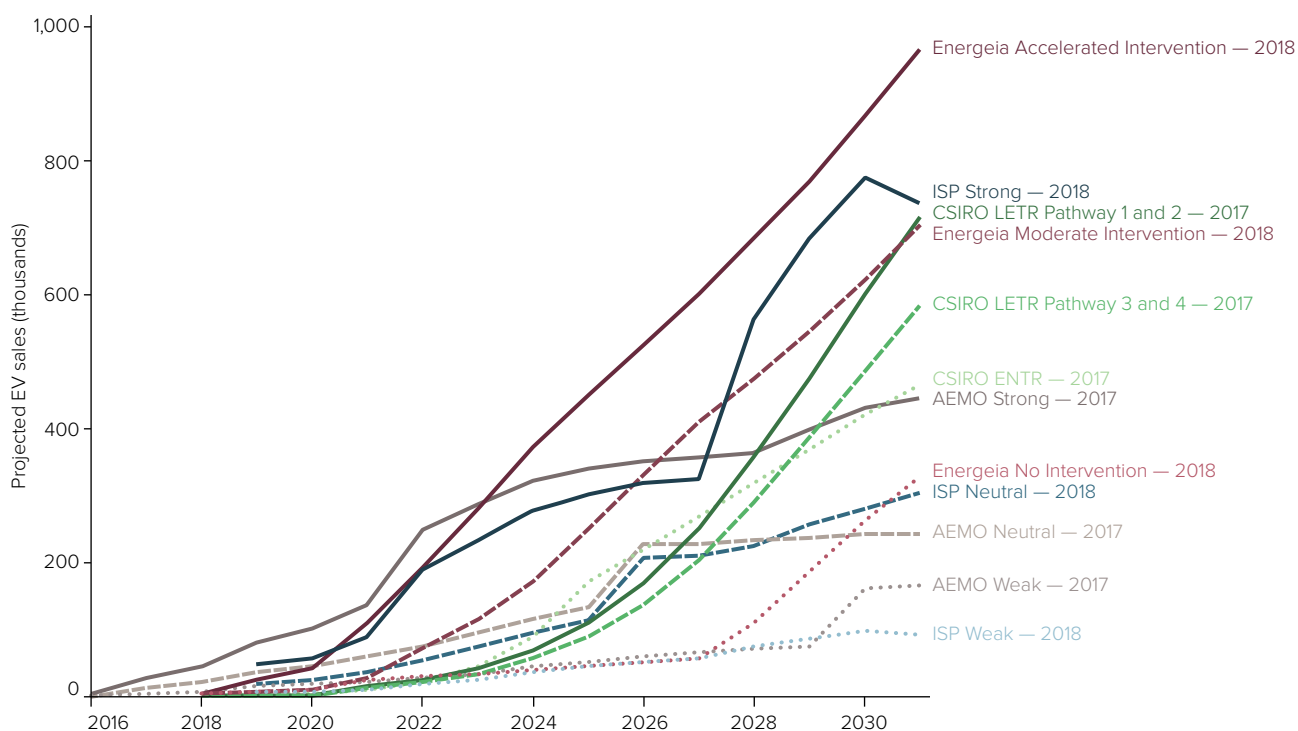
installed, and consumers are being offered a more diverse range of vehicles to meet their needs.

Electric vehicle owners also stand to save significant recurrent costs. Operating costs, including fuel and maintenance, are significantly lower than for internal combustion engine vehicles.¹⁰² Presently, electric vehicle owners spend \$380 per annum on maintenance, while internal combustion engine vehicle owners pay \$750 per annum.¹⁰³

As with MaaS products which increase the availability and affordability of carsharing as an alternative to traditional public transport use, governments will need to be alert to the risk of cheaper motoring leading to congestion impacts. More positively, cheaper driving will be particularly beneficial for the rural and remote communities which suffer the most from high per-kilometre travel costs.

Several leading research organisations, government agencies and industry groups have produced electric vehicle uptake projections (Figure 4). The range of projections highlights significant uncertainty, but also the consensus view that adoption of electric vehicles into the Australian market will accelerate between 2020 and 2030.

Figure 4: Australian electric vehicle sales projections are increasingly optimistic



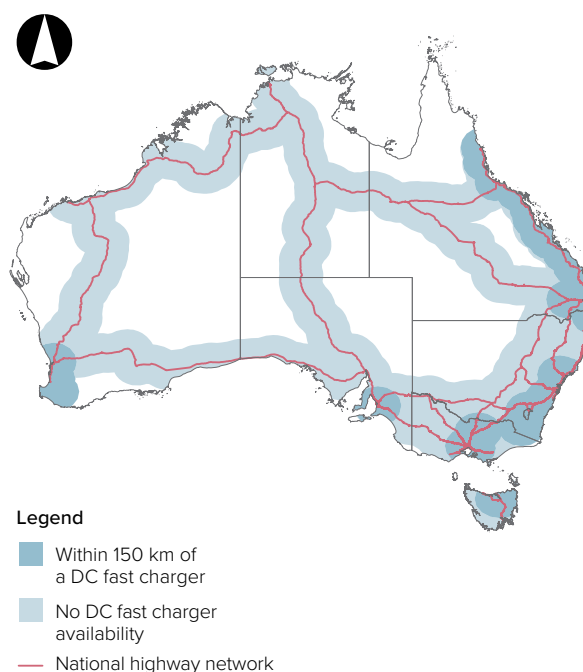
Source: Clean Energy Finance Corporation (2018)¹⁰⁴

Given this uncertain timeframe and the lack of current electric vehicles on our roads, it is not surprising that there are fewer than 100 publicly available Direct Current (DC) fast chargers in Australia,¹⁰⁵ which results in limited coverage on the National Highway Network (Figure 5). DC fast charging stations can provide 70 km of driving range for every ten minutes of charging.

The current lack of charging infrastructure increases consumers' range anxiety. This anxiety is more pronounced in regional, remote and rural areas where charging infrastructure is required to connect communities and allow inter-regional travel. These communities do not offer the economies of scale to justify private investment in charging infrastructure at this time. Infrastructure Australia's 2019 *Infrastructure Priority List* has recognised this and identified a national electric vehicle fast-charging network as a high priority for the next five years.¹⁰⁶

Some investment in a national charging network has already begun. The Queensland Government has committed to installing a 1,800 km fast charging network from the state's southern border to Cairns. The Australian Government, through ARENA, is separately providing \$6 million to develop 21 public fast charging stations.¹⁰⁷ This network, which will space stations no more than 200 km apart, will link up driving routes from Brisbane to Adelaide (via Sydney and Melbourne) and in separate sections of Western Australia. Private companies, including Tesla and the NRMA, have also installed chargers, and several local councils have been proactive in installing slower kerbside chargers in residential areas.¹⁰⁸

Figure 5: As at November 2018, non-proprietary fast charger coverage of the National Highway Network is limited to major population centres



Note: Coverage as of 15 November, 2018.

Source: Infrastructure Australia analysis of PlugShare (2018)¹⁰⁹

45. Challenge

Many regional, remote and rural communities do not have the economies of scale to justify private investment in charging infrastructure. Without charging infrastructure, users in these areas will have fewer opportunities for electric vehicle uptake.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



There is universal agreement on the need to plan for autonomy

The need to plan for fully automated vehicles is already starting to reshape the way we think about the role of transport, whether in our cities or in connecting Australia's most remote communities.













The five standardised levels of vehicle autonomy are outlined in Figure 6. Based on the Level 2 automation already offered by many newer vehicles on Australian roads, the irreversible move towards, ultimately, full vehicle automation is already changing how road users interact with their vehicle and experience their journey.

Increased vehicle autonomy can benefit all types of places, from fast-growing cities to rural and remote communities alike.

Many analysts are anticipating that Level 4 automation will be commercially available before 2025.¹¹⁰ Beyond that point, as shown in Figure 7, forecasts for the achievement of Level 5 automation span a wide range of possible timeframes.

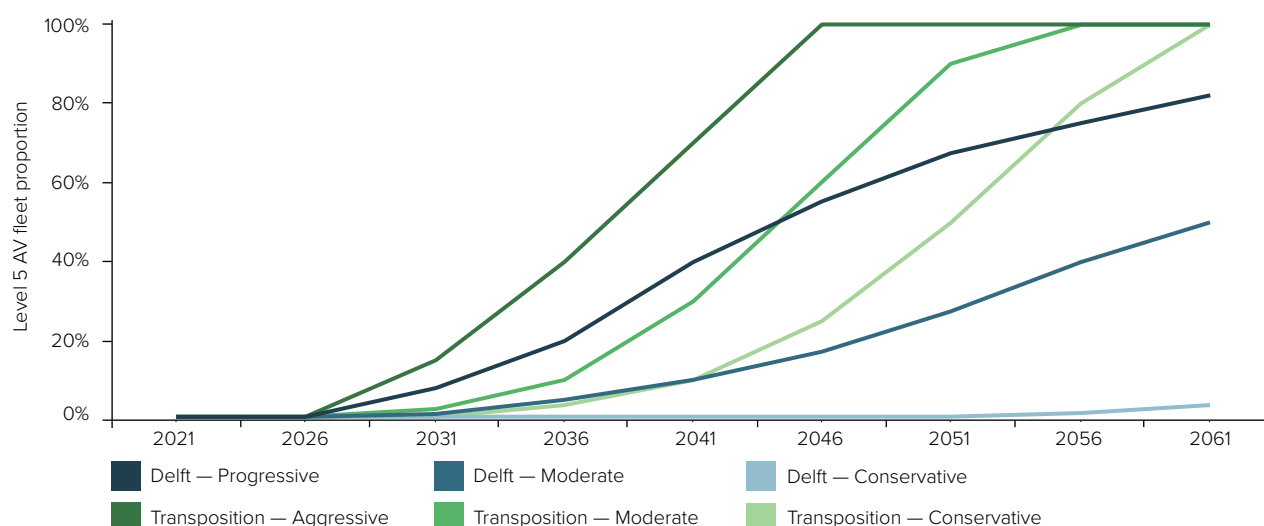
Uncertainty around the timing of the final step to full vehicle automation is to be expected. The total benefits of this technology, especially the road safety gains, will only be maximised level of uptake is beyond the point at which the risk of a fully automated car sharing the road – and colliding – with a less sophisticated vehicle falls away. Regardless of when this point will be reached in Australia, current transport network planning decisions must be informed by the assumption that roads built today with 40 year predicted lives will in time be used by fully automated vehicles.

Figure 6: There are six levels of autonomous driving

	L0	L1	L2	L3	L4	L5
	No automation	Driver assistance	Partial automation	Conditional automation	High automation	Full automation
Driver	 <p>In charge of all the driving</p>	 <p>Must do all the driving, but with some basic help in some situations</p>	 <p>Must stay fully alert even when vehicle assumes some basic driving tasks</p>	 <p>Must be always ready to take over within a specified period of time when the self-driving systems are unable to continue</p>	 <p>Can be a passenger who, with notice, can take over driving when the self-driving systems are unable to continue</p>	 <p>No human driver required – steering wheel optional – everyone can be a passenger</p>
Vehicle	<p>Responds only to inputs from the driver, but can provide warnings about the environment</p> 	<p>Can provide basic help, such as automatic emergency braking or lane keep support</p> 	<p>Can automatically steer, accelerate, and brake in limited situations</p> 	<p>Can take full control over steering, acceleration, and braking under certain conditions</p> 	<p>Can assume all driving tasks under nearly all conditions without any driver attention</p> 	<p>In charge of all the driving and can operate in all environments without need for human intervention</p> 

Source: Intel (2018)¹¹¹

Figure 7: Analysts are uncertain about when level 5 automated vehicles will become a sizeable portion of our fleet



Source: Jacobs (2019)¹¹²

With an eye to this future, current driverless vehicle trials in Adelaide,¹¹³ and Sydney,¹¹⁴ and associated legislative changes, represent necessary steps towards high automation.¹¹⁵ Industry is developing the underlying technology for autonomous vehicles by investing substantial amounts into research and development. Some notable examples:

- Waymo, a subsidiary of Google Alphabet, is running large-scale trials and its vehicles have travelled 10 million kilometres on public roads since 2009.¹¹⁶ Waymo has launched the world's first fully automated ride-hailing service in Phoenix, Arizona.
- General Motors is planning to launch an autonomous ride-hailing service in 2019.¹¹⁷
- Volkswagen is planning a 2020 vehicle release and has committed \$50 billion by 2023 to investment in new technology, digitisation, autonomous driving and electrification.¹¹⁸
- Ford, Tesla and Daimler are planning to release self-driving cars within the next three years, and have trials under way.¹¹⁹

Level 3 automation is already available for some commercially available passenger vehicles, such as the luxury Audi A8. While this vehicle offers a glimpse of the technology that will eventually be common to all of Australia's fleet, the A8's autonomous functionality cannot be used on Australian roads until permitting legislation is in place. This is an example of Australian regulation not keeping pace with the speed of technological development.

Regulations are vital to optimising community and consumer outcomes

Autonomous vehicles have the potential to improve safety, reduce costs, create more liveable communities and offer more convenient transport services. However, the practical impacts of the roll-out of this technology are as uncertain as its timing.

The ability for vehicles to travel safely close to one another could result in significant improvements to traffic congestion, travel times and parking space requirements. The cost of ridesharing would drop significantly without the need for a driver. Under scenarios where vehicles are shared between multiple users, the gains could be even larger. The biggest improvements are arguably to be expected in safety, with around 94% of car accidents said to be caused by human error.¹²⁰ Alongside this, time spent in traffic in a Level 5 autonomous vehicle could be more productive and enjoyable than hands-on driving through congestion.



However, autonomous vehicles could also have negative impacts on our transport networks and communities. The increased quality, access and reduced cost offered by autonomy could result in more users favouring car use over public transport, potentially increasing road congestion.¹²¹ Our kerbsides could also become an even more contested space, as people will need room to get into or out of vehicles. There is also a concern that autonomous vehicles would circulate empty when not in use, increasing the total number of vehicle kilometres travelled. Autonomous vehicles might encourage people to live further away from dense urban centres, increasing urban sprawl and road use. Finally, unless or until completely separate networks are available for the use of active transport and motor vehicles, the need for autonomous vehicles to share space with pedestrians and cyclists could be problematic.

Our roads and cities will also need time and investment to adapt to autonomous vehicles. Since autonomous vehicles would not require a parking space at the end of each trip, they could free up space in our cities. High levels of automation could reduce the need for on and off-street parking and potentially traffic signals, assuming the retention of road-crossing solutions for active transport users. Analysts estimate that as much as 97% of the space used for parking could be repurposed,¹²² albeit this

would require autonomous vehicles to continue moving around the road network even when not in use, and at night. This is unlikely to be efficient. Ideally vehicles would be able to access parking for maintenance and during periods of low demand.

Autonomous vehicles clearly face policy, community and regulatory barriers before they can safely operate on Australian roads. In 2016, the National Transport Commission identified more than 716 provisions in transport-related laws and regulations that could act as barriers to autonomous vehicles. Some governments are being proactive and setting the foundations for a positive autonomous vehicle future. In June 2016, South Australia was the first jurisdiction to pass laws to allow road trials of connected and automated vehicles.¹²³ In May 2017, states and territories agreed to national guidelines for trialling automated vehicles.¹²⁴

In 2019, the Autonomous Vehicles Readiness Index ranked Australia as 15th out of 24 countries. This shows that Australia is making progress towards the deployment and use of autonomous vehicles on our roads, while falling short of best practice.¹²⁵ Continued work is required to turn high-level agreements achieved thus far into reforms constituting a nationally consistent regulatory framework that supports the safe commercial uptake and use of new technology and systems.

46. Challenge

There is a lack of appropriate regulation, trials and physical infrastructure to enable the use of many cooperative and autonomous vehicle features. Without action, the benefits offered by cooperative and autonomous vehicles will be missed.

**When this
will impact:**

0-5

5-10

10-15

15+

**Where this
will impact:**



5.4 International, interstate and inter-regional connectivity

At a glance

Given Australia's size and isolation, long-distance travel is a crucial function for our transport network. Infrastructure must cater to varied trip patterns, usage densities and climates. This section covers:

- International travel – the air travel sector faces airport congestion, curfews and security delays, while our growing cruise industry lacks berths in the major cities that need them most.
- Interstate and regional travel – regional roads are poorly funded and maintained, while flights suffer from high costs and low demand. Rail struggles to compete, but could expand.

Long-distance travel is important to Australia

Long-distance travel is an inevitable part of living in Australia. We are one of the largest countries on earth, with enormous distances between our major cities, regional centres, tourist hubs and remote communities. Perth, for example, is considered one of the most remote cities in the world. It is closer to East Timor and Jakarta than to Sydney.

Australia is also isolated from the rest of the world. We are home to three of the top 10 longest direct commercial flights in the world, Perth–London (ranked 3rd), Sydney–Houston (ranked 6th) and Sydney–Dallas (ranked 7th).¹²⁶ Despite our isolation, Australians travel extensively and we receive millions of international visitors each year. In 2018, there were over 40 million people movements across our border, with 99% of these arrivals and departures being by air.¹²⁷

Our international, interstate and inter-regional transport infrastructure needs to cater for a very broad range of trip patterns, density of use and climates. From our busy international airports to our critical but sparsely-used remote roads, our long-distance transport networks face various funding, regulatory and accessibility challenges.

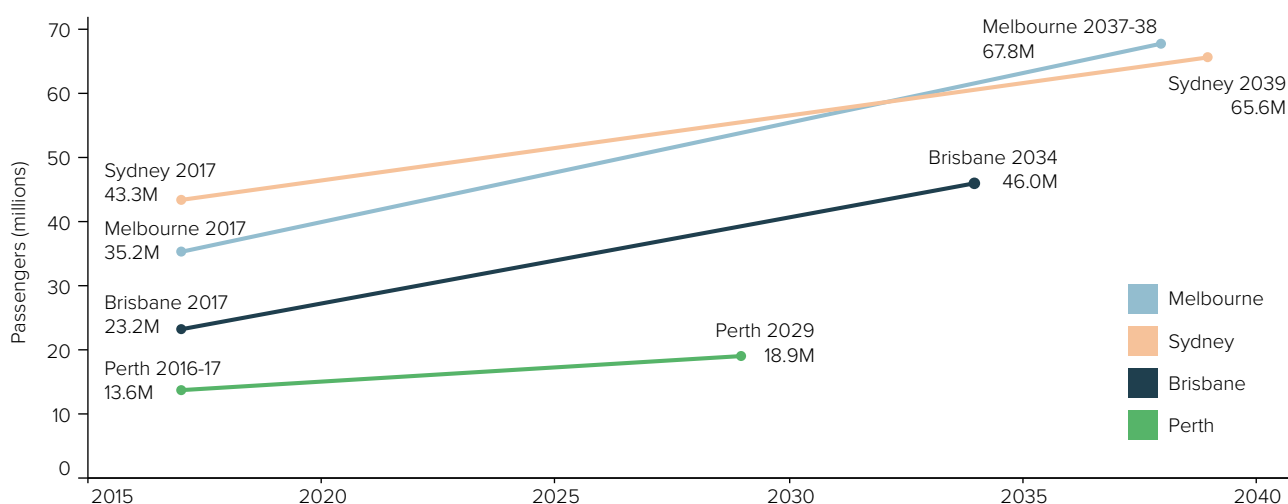
Airports are our gateways to the world

Our international airports are critical to our connectivity with the rest of the world. Nearly all our international travellers (tourists and returning Australians) come through our airports, with over 20 million international arrivals each year.¹²⁸

International airports are also central to our economy. In 2016-17, they facilitated about \$32.3 billion in tourism activity and either directly created or supported over 200,000 jobs.¹²⁹

Traffic is growing, with all of our major international airports forecasting significant growth in passenger and aircraft movements in the next 20 years (Figure 8).¹³⁰

Figure 8: Our capital city airports are forecasting strong growth



Source: Australian Airports Association (2018)¹³¹

Domestically, Australians moving around the country are also highly reliant on flying. With nearly 10 million annual passenger seats on offer, the route between Sydney and Melbourne was the second busiest globally in 2018, Sydney–Brisbane is eighth. In an unpredictable environment where external influences ranging from climatic events to fuel price fluctuations can disrupt aviation operations, this level of dependence presents continuity risks.¹³²

With aviation activity increasing in step with the expansion of the cities connected by our busiest flights, congestion is a major challenge on both the air and land sides of our airports. In response to the growth in demand, four of Australia's major cities are undergoing significant air capacity upgrades. The Australian Government is building a second and curfew-free airport in Western Sydney, and the major 24-hour airports in Melbourne, Brisbane and Perth are constructing or planning additional runways. Brisbane's new runway is due to open within a year, while the upgrades to Perth and Melbourne are still in planning.

In addition to our major airports, international flights also use smaller city and regional airports such as Adelaide, Cairns, Darwin, Broome, Port Hedland, Gold Coast and Sunshine Coast. These airports are important for local tourism and economic development, often acting as multimodal transport hubs and centres for commercial activity.¹³³

Australia's major airports are mature assets with established private sector operators. Airports are economic entities whose income stream is made up of aircraft landing fees, and varying levels of non-aeronautical revenue such as retail leases and parking fees.

Although our major international airports are privately operated, governments continue to play an important role across numerous aspects of airports' daily operation, regulation and long-term planning, including:

- Monitoring and reporting through the ACCC
- Regulatory oversight by the Productivity Commission
- Setting aviation safety standards, security, immigration and customs processes

- Air traffic control and fire and rescue (through Airservices Australia)
- Providing supporting ground transport links such as local roads and public transport.

Our major airports have faced many challenges in recent years, particularly with growing ground transport congestion around Sydney,¹³⁴ and Melbourne airports.¹³⁵ This has resulted in significant infrastructure investment around these two airports, with the New South Wales Government currently undertaking preliminary design works on the Sydney Gateway package of road upgrades around Kingsford Smith Airport, and the Victorian Government having recently announced a rail link to Melbourne's Tullamarine Airport. Significant investments to improve transport connections to smaller airports in Brisbane and Canberra have been undertaken over the past 5 to 10 years. The Forrestfield Airport Link will provide a heavy rail connection to Perth Airport when complete.

Our airports' operations are also circumscribed by regulation. Sydney and Adelaide airports are subject to curfews in order to reduce noise impacts on the residents of surrounding densely-populated and long-established suburbs. The regulation of Sydney's Kingsford Smith Airport focuses on the type of aircraft allowed to fly between 11pm and 6am, and the number of hourly movements during operating hours, as opposed to the resulting level of noise or other impact. The Productivity Commission is currently investigating the economic regulation of airports. In its draft report from February 2019, the commission notes that restrictions on operating hours protect communities from noise but can, by forcing land-side movements to happen when cities' transport networks are already at their busiest, come at the cost of airport efficiency.¹³⁶

Finally, delays can be caused by security, customs and immigration processes. Australia's security and customs procedures play an important role, but improvements can always be made. Australia ranks 24th in the world for the 'burden of customs procedures' at our gateways, behind many of our OECD competitors.¹³⁷

47. Challenge

There is congestion on roads around our major airports, particularly in Sydney and Melbourne. Unless addressed, travelling to airports will become increasingly unreliable, leading to longer travel times.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



48. Challenge

Some of our major airports are subject to operational restrictions reducing airport efficiency however adding to local amenity. Without regular reviews to ensure regulation is fit for purpose, the efficiency of our airports could be unnecessarily compromised.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Roads are the lifeblood of our regions

Roads are the 'heavy lifter' of regional transport, accounting for the vast majority of passenger kilometres travelled in regional areas.¹³⁸ This is because the dispersed nature of jobs and people make cars the most practical mode of transport for most trips.

Roads are typically the most important – and often only – link between regional and remote communities and other centres, cities and regions. They are therefore critical in ensuring access to key services such as health and education, and for tourists and travellers to sustain the visitor economy away from cities. Roads are also critical for transporting agricultural and mineral products.

However, there are substantial challenges in ensuring regional roads are sufficiently funded and maintained, appropriately serve remote communities, and are safe.

First, road funding and maintenance is not directly linked to use or road-related revenue. This means that funding and maintenance is susceptible to the budget limitations of different levels of government. While the array of available programs may be significant in the type and quantity of funding on offer, in the absence of national framework to guide investment and maintenance there is inconsistency between jurisdictions in the application of these resources. Long-distance routes crossing state and territory borders are particularly at risk in this respect.

Second, regional roads in particular lack funding consistency. While key freight routes and high road safety risk locations in regional areas generally attract federal and state funding, most roads are the responsibility of local governments. These governments are often fiscally constrained, have very extensive networks to maintain and deal with significant road degradation due to heavy vehicles and extreme weather.

Third, the use of regional and remote roads is less safe than in urban areas. A combination of higher speeds, driver fatigue from long hours spent on the road, the spreading of enforcement resources over a wide area, and infrastructure of a variable quality mean crashes tend to be more serious outside our cities. In terms of exposure, there is therefore a greater rate of fatalities and serious injuries occurring on regional roads.¹³⁹

Finally, the major and accelerating transformation in vehicle technology will present several challenges and opportunities for our regions over at least the next 15 years. Specifically:

- Slow deployment of charging infrastructure may delay electric vehicle access and uptake in regional areas. Charging stations are largely concentrated in our cities and a lack of stations has been identified by around two-thirds of motorists as a key barrier to the adoption of electric vehicles.¹⁴⁰
- Automation and connectivity may help reduce crashes, making longer trips undertaken in a range of adverse conditions more viable.

49. Challenge

Governance and funding of our regional road networks is inconsistent and lack transparency. This means funding and maintenance is subject to budget volatility of different levels of government. Without change to road network governance, our regional roads will continue to be poorly funded, maintained and safety may decline.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Regional aviation services often struggle to be viable

Aviation services provide important inter-regional connections. However, ensuring the viability and availability of regional air services will continue to be a challenge for the foreseeable future.

Significantly outnumbering our 16 major airports, there are over 160 regional and remote airports in Australia. These are generally owned, operated and maintained by local governments. These governments often face significant fiscal constraints and the majority of regional airports (60%) operate at a loss. This is because airports require substantial and ongoing expenditure on maintenance and safety and security compliance.

Remote airstrips can also face difficulties due to extreme weather and the limited ability of local government and communities to ensure they are safe. These airstrips are a critical link for remote communities to key services, particularly in northern Australia. The Federal Government operates a remote airstrip upgrade program. Airstrip owners and operators can apply for funding to ensure their airstrips can remain functional.

There are also challenges to ensuring sufficient and affordable services to regional and remote towns. Regular air services on domestic routes have been deregulated since 1990. However, where demand is insufficient to justify commercially-operated services, government intervention has been necessary to ensure a minimum level of service.

Numerous Federal Government schemes are in place, including the Remote Air Service Subsidy Scheme (RASS) and the Enroute Charges Payment Scheme. The programs aim to subsidise and reimburse costs and charges. Some state governments also regulate regional air routes which have insufficient demand for commercial operations, to ensure competition between airlines. Regulated routes generally grant a monopoly to a single carrier and stipulate a maximum fare.

Despite federal and state government subsidies and regulation, regional airfares have become a focus for governments in recent years. A Western Australian Parliamentary inquiry submitted its report into regional airfares in late 2017, and a Commonwealth parliamentary inquiry is due to report in June 2019.

The Western Australian inquiry found there are community perceptions that regional and remote airfares are too high.¹⁴¹ This is particularly the case for airfares on unregulated routes, where the government has left prices to be determined by operators.¹⁴²

The Australian Airports Association and numerous regional and remote communities have called for the Australian Government subsidy schemes to be expanded. There have also been calls for greater state government intervention of unregulated air routes to improve transparency in the methodology used to set fares, thereby helping to highlight whether further regulation may be required.¹⁴³

50. Challenge

Regional aviation often struggles to be financially viable and customers view it as costly. Without action, regional and remote communities will lack access to air services and affordable airfares.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Regional rail could play a bigger role

Regional railways serve a broad range of functions. They can act as regular commuter services, helping to link satellite communities to major cities. They can also facilitate regional connectivity, linking our regional centres and smaller towns. Australia also has an interstate rail network, which carries passenger services between major capital cities.

Regional railways can broadly be split into three markets that each serve different geographical areas:

- **Short-distance intercity** services are the most heavily patronised and generally link major cities to satellite cities and major regional centres. Examples include Newcastle-Sydney-Wollongong, Melbourne-Ballarat, Sunshine Coast-Brisbane-Gold Coast and Perth-Bunbury.
- **Long-distance intercity** services connect interstate capitals with each other and with regional centres. Examples include NSW Trainlink's Sydney-Brisbane, Sydney-Canberra and Sydney-Melbourne services.
- **Leisure and heritage** services operate largely for tourists and railway enthusiasts. Examples include the Kuranda Scenic Railway and the Indian Pacific. These services can play an important role in regional and remote tourism as they bring customers to relatively remote towns.

Our regional rail services carry a relatively low share of passengers. Australia's vast distances mean that long-distance rail does not compete with the travel times offered by airlines. In regional and remote Australia, where population centres are small and widely dispersed, most communities are not served by rail, or by such a low service frequency that this mode struggles to compete with the flexibility of car use.

However, there is the potential for some regional railways to play a bigger role in our transport networks. Our short-distance intercity services are important for commuters as well as for city-to-city connectivity, and have the greatest potential to grow their market share. These services often have uncompetitive travel times compared to driving but can still be well-patronised, particularly for commuting trips to major employment centres and CBDs.

The Victorian experience has shown that targeted track upgrades can reduce travel times, increase frequencies and result in significant patronage growth for short-distance intercity services. Following the Victorian Government's Regional Fast Rail Program and Regional Rail link construction, patronage has doubled on Victoria's regional trains, which are now experiencing crowding.¹⁴⁴

Improvements to longer-distance intercity services, particularly along Australia's east coast, have long been debated and there have been numerous feasibility studies. The most recent government-led study, published in 2013, examined a possible high-speed railway linking Brisbane-Sydney-Canberra-Melbourne and stopping at numerous smaller cities and regional centres along that route. The study found the project would come at a cost of \$114 billion (\$2012), would have a net present value of \$101 billion and would ideally be completed by 2058. Infrastructure Australia has recommended that a corridor for high-speed rail connecting these cities be reserved as soon as possible.¹⁴⁵ The New South Wales Government is investigating four potential routes in a fast intercity rail network, with the assistance of Australian Government funding.¹⁴⁶

51. Challenge

Our regional railways generally have uncompetitive travel times with cars and planes. This means they carry a relatively small share of passengers. Unless travel times are improved, regional rail will continue to play a small role, meaning regional customers have less choice when they choose to travel.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Cruise ships are a small but growing industry

A small but growing area of Australia's visitor economy, and source of international arrivals, is the cruise shipping sector. There were 1.34 million cruise passengers in 2017, the number having quadrupled since 2010.¹⁴⁷ The cruise industry contributed about \$5.28 billion to the economy in 2016-17.¹⁴⁸

Cruise ships can be important to our major cities but also at regional ports, where the number of passengers who disembark can be very significant relative to local populations and tourism numbers. At some smaller ports, such as Darwin, cruise ships also represent a particularly welcome economic opportunity because they can boost tourist numbers in traditionally quieter times of the year.

Governments play a similar role for cruise ships as they do for airports, by ensuring suitable land transport links, pilotage, security, and customs and immigration processes.

An additional role is to ensure sufficient berthing space for cruise ships. This has increasingly become a problem, particularly in Sydney. This is the marquee port for Australia and the South Pacific Region because of its harbour and iconic structures like the Opera House and Sydney Harbour Bridge.¹⁴⁹ Sydney Harbour is the only port in Australia to have two cruise ship passenger terminals – at Circular Quay and White Bay.

However, the growing popularity of cruise ships, and the trend towards larger ships, mean there is insufficient berthing capacity in Sydney. The White Bay terminal cannot accommodate larger ships because they cannot fit under the Harbour Bridge. This lack of capacity could harm cruise shipping in Australia, with some cruise operators citing Sydney's lack of capacity as the reason for Australia not being on their itinerary in 2018-19.¹⁵⁰

The NSW Government is investigating opportunities to increase berthing capacity and this initiative was added to the *Infrastructure Priority List* in 2019.

Cruise ships in Darwin can contribute to regional tourism

Darwin Port already acts as a final destination (or turnaround port) for smaller cruise ships during its peak tourist season (the May to October dry season). This means that smaller vessels use the port as a beginning and/or end point for itineraries that typically explore the northern Australian coastline, with passengers often staying in Darwin before and after their cruise.

However, for larger international cruise ships, the season in Australia generally runs from October to April (the tropical north's wet season), when operators relocate their fleets to the South Pacific region for the southern hemisphere summer.

During this season, larger international vessels often include Darwin as a first or last port of call as the ships enter or leave Australian waters. Larger cruise ships generally use Darwin as a transit port, meaning passengers are often disembarked for a few hours or a day to explore the city. This can provide an important economic injection during the low tourist season for Darwin.

However, Darwin's port has limited capacity. Future growth in cruise numbers will depend on the port's ability to handle passenger and related technical services, such as refuelling and provisioning, on a larger scale.¹⁵¹

52. Challenge

The popularity of cruise ships in Australia is growing, producing important tourism opportunities for fast-growing cities and regional centres. However, there is a lack of berths for international cruise ships, particularly in Sydney. Without additional berthing capacity, Australia will lose cruise ships and tourist visitation will decline.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



5.5 Funding and maintaining our transport assets

At a glance

While the public sector invests heavily in transport, private spending has started to decline. This section discusses funding and maintenance challenges the sector faces in the next 10–15 years:

- There is a growing disconnect between how far people drive and how much they pay.
- Public transport projects can be costly, and funding is often not transparent.
- Regional and remote areas must maintain large networks with limited funding.

It also looks at new technologies and the potential revenue that comes with them.

Asset maintenance and renewal are critical to our transport networks

There are major challenges to sustainably maintaining services and assets. The capability of Australian governments to plan, manage and undertake works to maintain and renew the assets in our transport network has not improved in recent years. In the 2015 *Australian Infrastructure Audit*, we highlighted that maintenance data are inconsistent across infrastructure managers. Unfortunately, there is still no consolidated national dataset for transport infrastructure maintenance, and guidelines remain ad hoc and do not cover each sector equally or in sufficient detail.

The Australian Local Government Association and Austroads have published reports which help to quantify maintenance expenditure and to determine appropriate methods to assess the cost and benefits of maintenance over time.¹⁵² Although these are helpful contributions, there are still no agreed service levels which asset maintenance should aim to achieve.

In fact, there is no single metric to determine the appropriate level of maintenance, renewal or rehabilitation for a transport asset. Ideally, expenditure should be sufficient to maintain a pre-determined service level and should be part of a detailed asset management plan. However, in practice, determining service levels can be difficult (particularly for aged infrastructure), and it can be challenging to distinguish between maintenance expenditure and expenditure which might enhance the economic benefit of an asset.¹⁵³

Regardless of service level requirements, the funding challenge will become more pressing over time. Sectors that are heavily reliant on government funding rather than user charging, including roads (particularly in regional areas) and public transport, are most likely to suffer from inadequate maintenance regimes because expenditure on assets is not directly linked to their use.

53. Challenge

Asset maintenance lacks transparency, consistency and accountability. This is particularly the case for sectors that rely on government funding rather than user charges, such as roads and public transport. Unless addressed, maintenance of our transport networks will become increasingly unsustainable.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



There is competition for capital investment, asset renewal and maintenance funds

There has been substantial investment in transport infrastructure in recent years. Despite this expenditure there are major challenges to sustainably fund and maintain services over the next 10-15 years.

A lack of information and resourcing to plan and undertake asset management, limited or nascent mechanisms to link funding to needs, few incentives to improve efficiency, and declining revenues will all have consequences for the quality and affordability of transport services. These challenges are more pointed as we enter a period of rapid disruption in how transport services are provided, and as people's needs and expectations of the transport system change.

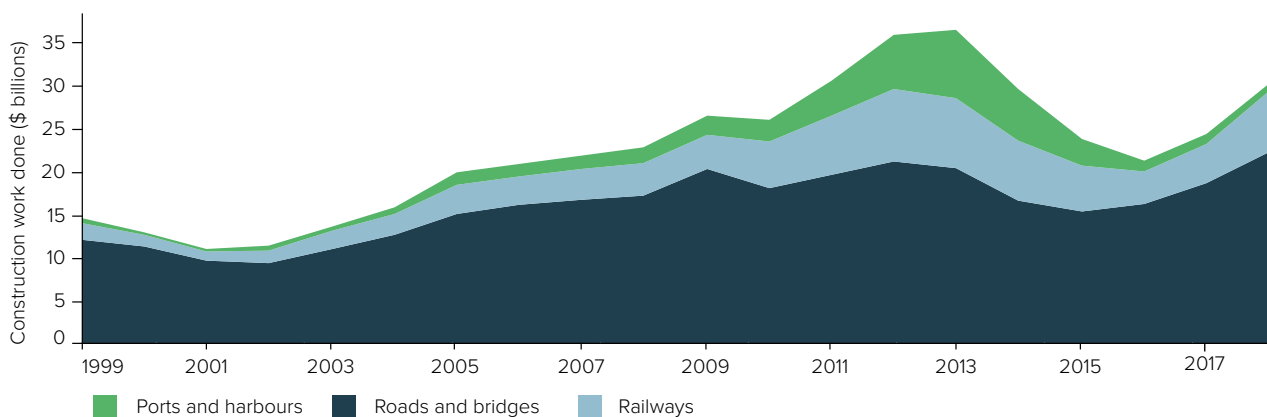
With some fluctuations, the average annual level of investment in all Australian transport infrastructure types has increased substantially over the last 20 years. The value of new construction work on our transport networks in 2017-18 was about \$30 billion, excluding the maintenance of existing infrastructure, as shown in Figure 9. In addition to the modes shown here, airports are estimated to have invested \$11.5 billion in improvements over the decade to 2018.¹⁵⁴

Private sector expenditure increased during the investment phase of the resources boom from 2007 to 2013, but is now declining as many projects move into their production phase. Public sector investments have focused on roads and large public transport projects, at a time of growing concern about congestion in our cities and lack of connectivity in regional areas. Most jurisdictions have major transport projects underway or committed, and investment is close to or above record levels depending on location.

State governments overwhelmingly shoulder the burden of transport funding. Public transport is a state government responsibility and can account for up to 60% of state capital budgets.¹⁵⁵ In terms of roads, the states provided close to two-thirds of total government funding in 2016-17 (Figure 10).¹⁵⁶

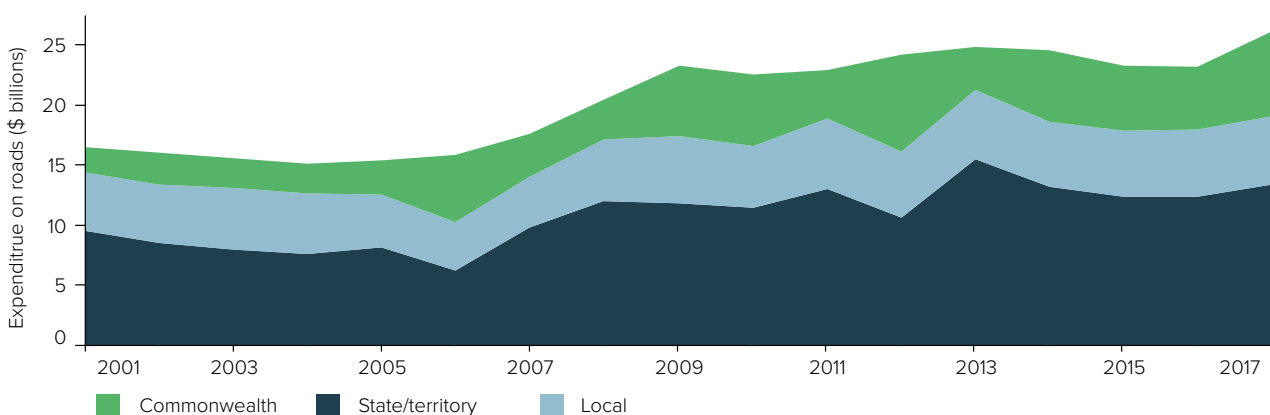
Every dollar spent on transport has an opportunity cost. In the case of government expenditure, the opportunity cost is the money that cannot then be spent on other services, such as health and education. The growth in transport capital expenditure in recent years means that transparency in decision-making around the allocation of funds is critical to levels of public confidence in our networks' long-term sustainability.

Figure 9: The value of transport sector construction has grown strongly in the last 20 years



Source: Bureau of Infrastructure, Transport and Regional Economics (2018)¹⁵⁷

Figure 10: State governments spend the most on roads



Source: Bureau of Infrastructure, Transport and Regional Economics (2018)¹⁵⁸

Road use, funding and expenditure are not adequately linked

There is no formalised link between how funds are raised from road users and how that money is spent. The principal forms of road-related charges are federal fuel excise, state registration and licensing fees and tolls.

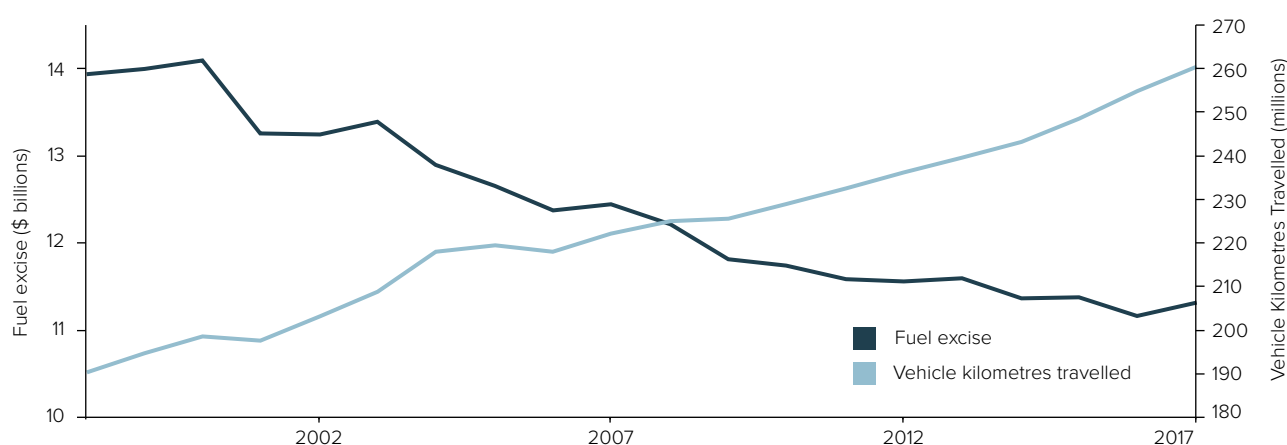
Fuel excise was originally designed as a proxy consumption-based charge, where revenue from a cost impost on litres of fuel purchased would increase with demand for roads and driving. However, the correlation between vehicle kilometres travelled and the demand for fuel no longer functions in the way it once did, with fuel excise decreasing in real terms and kilometres travelled increasing over the last two decades (Figure 11). This trend is likely to worsen as cars become increasingly fuel-efficient and electric vehicles make up a growing proportion of our fleet.

This means that, in the short to medium term, fuel excise will be replaced as the principal form of road-related revenue by state-based charges which are not linked to the distance people drive, such as registration and licence fees. The existing and growing disconnect between the kilometres people

drive and how much they pay raises numerous challenges:

- **It is inequitable:** because people who rarely drive subsidise people who frequently drive. It also increasingly means that people who own newer and more fuel-efficient or electric vehicles pay less tax.
- **It is inefficient:** because road users are not charged for their use. This means that once registration and licence fees are paid, people are actually incentivised to drive. In addition, drivers pay the same amount regardless of the time of day and location of their trip. This means there are no financial incentives for people to change their travel habits to be more efficient, by driving after peak hour or switching to public transport.
- **It is unsustainable:** because fuel excise, the largest single contributor of road-related revenue, will continue to decline, meaning expenditure will outstrip income.
- **It is not transparent:** because there is no link between usage and expenditure, the reasons and justification for capital and maintenance expenditure decisions are rarely published and can be inconsistent.

Figure 11: Revenue from fuel excise declined while vehicle kilometres travelled grew



Source: Bureau of Infrastructure, Transport and Regional Economics (2018)¹⁵⁹

54. Challenge

There is no clear link between expenditure on roads and usage, which means road expenditure is inequitable, inefficient, unsustainable and lacks transparency. Without reform, revenue from fuel excise will decline, drivers will not be charged fairly and people will be incentivised to drive, contributing to congestion.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Major public transport investment decisions lock in ongoing subsidies and lack transparency

The cost of public transport projects can be large, taking up a significant proportion of state government budgets.¹⁶⁰ It is therefore critical that the funding of public transport projects is as transparent as possible.

Some large public transport projects have published business cases, which is helpful for transparency. However, announcements on projects are sometimes made prior to proper assessment.¹⁶¹ This is most often the case with 'big ticket' expensive infrastructure projects, which do not have the same economic benefits as more modest enhancements. In addition, post-completion reviews are rarely undertaken or published, meaning we often do not know whether investments were justified, and we cannot learn all the available lessons from past projects.¹⁶²

In addition to the upfront cost of projects, it is important to remember that, under prevailing fare regimes, public transport requires indefinite operating subsidies. Our major public transport networks have operating costs in excess of \$9 billion per annum.¹⁶³ Cost recovery from fares in Australia is relatively low by international standards, averaging between 20% and 30%.¹⁶⁴ Research commissioned by Infrastructure Australia estimates there is an annual public transport operating subsidy by governments of about \$7.4 billion.¹⁶⁵

The scale of the operating subsidy provided to public transport can make it vulnerable to shifts in government policy as well as changes in budgetary conditions. Given the importance of maintaining and expanding public transport, especially in our rapidly growing cities, improving cost recovery is becoming increasingly important as it will ensure the sustainability and stability of public transport services over the long term.

Smaller, efficiency-enhancing projects often have higher returns

Large infrastructure projects are frequently in the media and the subject of significant public debate. However, smaller projects, such as 'better use' interventions to improve the productivity of existing assets, cost less and generally create better economic returns.

Of the projects submitted to Infrastructure Australia for assessment between 2016 and 2018, those with the highest benefit-to-cost ratios were also the cheapest (Figure 12). This is because

larger projects generally include significant upfront costs, with benefits being realised many years later. A discount rate is applied to benefits that accrue in later years, so they can be compared on the same footing as projects that deliver benefits earlier. While major projects can be critical to Australia's long-term liveability, smaller initiatives also demand attention.

For more information, see Infrastructure Australia's *Assessment Framework*.¹⁶⁶

Figure 12: Lower cost projects often have higher benefit-cost ratios



Source: Infrastructure Australia analysis

55. Challenge

Public transport investments and operating subsidies are substantial, but decisions lack transparency. Unless addressed, public transport will continue to be subject to political cycles and budget conditions.

When this will impact:

0-5

5-10

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Where this will impact:



Local governments face challenges in maintaining regional and remote assets

The lack of transparency regarding road funding in Australia, combined with the inconsistency of asset management and financial planning standards and practices across local governments, is particularly problematic in regional and remote areas. Local governments in regional and remote Australia face the dual challenge of maintaining geographically extensive networks while having a relatively low revenue base from which to fund roadworks. The NRMA has identified that local governments in NSW face a roads maintenance funding backlog that grew from \$1.96 billion in 2016 to \$2.2 billion in 2018.¹⁶⁷

Federal and state-significant roads in regional areas are usually key freight routes, and as such more likely to attract funding for both capital and maintenance purposes. However, local government roads do not usually attract the same degree of freight traffic, and therefore may not be subject to the same attention and funding arrangements.

In addition, local government can find it difficult to justify maintenance expenditure on roads, particularly in sparsely-populated areas, due to low traffic levels. This can be problematic for remote communities, who are reliant on their roads to access key services such as health care and education. While regional groupings of councils in states including Victoria

and Queensland have had some success in sharing data and, in some cases, coordinating works on local roads, this approach may be harder for the most isolated areas.

Regional local governments are currently reliant on federal and state government grants, which as with any grants program can be subject to unpredictability. Grants from government are also generally for new projects, and do not include ongoing funding for maintenance. In other words, while a grant may be welcomed in the short term, it can actually increase the cost burden on local governments in the longer term.

Regional local governments face similar challenges in trying to maintain and operate airports. Over 60% of regional airports currently operate at a loss and about 40% expect to continue operating at a loss in the foreseeable future.¹⁶⁸

Regional airports are capital-intensive and require ongoing maintenance and upgrades in line with strict safety and security regulations. However, unlike larger airports, they do not have the same revenue-diversification options such as retail parks, hotels, parking fees and rent from businesses.

It is projected that regional airport operating costs will increase by 38% over the next decade, with an infrastructure funding shortfall of \$170 million.¹⁶⁹

56. Challenge

Regional and remote local governments struggle to fund and maintain roads and airports. Local governments often have relatively small revenue bases but are responsible for the maintenance of expensive transport networks. Without addressing funding shortfalls and maintenance practices, regional and remote infrastructure will become increasingly unsustainable.

When this will impact:

0-5

5-10

10-15

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Where this will impact:



New revenue streams are emerging

The challenge of sustainably funding our transport networks in the future may be exacerbated by emerging technologies and business models. Threats to revenue are presented by electric vehicles, whose users do not pay fuel excise, and by shared and automated vehicles, as multiple ownership and on-demand transport use could lead to a decline in registration revenues.

However, emerging technologies also provide an opportunity. Improved communications and tracking technologies, combined with readily available data, mean there are growing opportunities to expand existing revenue streams and take advantage of emerging sources of income.

Road network user charging has long been identified as the most economically efficient means of charging for our roads.¹⁷⁰ Technology has helped to overcome many of the technical barriers for implementing road user charging, with widely available GPS data and growing connectivity between vehicles and roadside infrastructure. A national road user charging regime is increasingly regarded as an option for addressing declining fuel excise revenue and a potential future decrease in registration revenue.¹⁷¹ However, in the absence of jurisdictional champions even slow progress in moving towards such a regime has faltered if not stalled.

In addition to charging for access to the physical transport network, access to services provided by the digital transport network may be charged in the future. As customers increasingly interact directly with third-party service providers and intermediaries in a blended public private service model, new pricing

models will emerge to manage access and costs. Customers are likely to gravitate towards seamless transactions and travel over the next 5-10 years, and transport payments will increasingly be funnelled via a single 'digital wallet' for mobility transactions.¹⁷² Subscriptions to a range of mobility services via the wallet may replace direct payments to providers for services (such as, tolls and tickets).

This changing relationship between customers and how they pay for mobility services will have implications for transport sector revenue, due to impacts on pricing, demand management and service choice. In this more fragmented transport operating environment, governments will need to consider opportunities to monetise information flows as one of a number of revenue options to compensate for lost sources.

Finally, there remain opportunities to expand existing revenue sources by improving mechanisms such as value capture and better managing third-party revenues.

Value created by transport investments can be disproportionately captured in property prices, as a windfall gain to property owners. Value capture taps into this by socialising some of the uplift in prices. In doing so, it can reduce the funds needed from other taxes and user-pays sources.¹⁷³

Operators are also increasingly capturing revenue from third parties through advertising and rental income. Most public transport operators, road managers and government transport departments are already actively seeking to enhance third-party revenue.

57. Opportunity

There are numerous emerging revenue sources for the transport sector, with many related to technological development and changing patterns of demand for transport. There is an opportunity for emerging revenue streams to improve the financial sustainability of our transport networks.

When this
will impact:

0-5

5-10

10-15

15+

Where this
will impact:



5.6 Passenger transport sustainability and resilience

At a glance

In the next five to fifteen years, our systems will likely experience radical physical and technological changes. Good planning will help us meet user needs, maintain the environment and support our economy.

This section reviews our growing emissions footprint and its impacts on our health. It looks at how we can use better planning and new technology to become more sustainable and resilient

The importance of sustainability and reliability

Over the next five to fifteen years, transport networks' physical and technological systems are likely to experience radical changes. How we design, build and use our current and future transport networks will have a large bearing on the long-term sustainability and resilience of our cities, regions, and rural and remote communities.

Sustainability and resilience are not fringe concepts, but good economic practice. They offer the opportunity to create vibrant communities that meet user needs, maintain the environment and support our economy. Delays in preparing the transport system for the impacts from external conditions such as a changing climate expose the economy to higher costs and more disruption.¹⁷⁴ Australia can meet its present needs without compromising the ability of future generations to meet their own.

Adapting to climate change and pursuing sustainable environmental outcomes form a core responsibility for infrastructure planners, owners and operators. While governments often have ambitions to incorporate sustainability and resilience into transport projects, the final investment can fail to reflect this ambition due to the lack of a consistent approach that supports the translation of goals into actions.

Conversely, resilience and sustainability have become significant concerns for many communities. Users are changing their transport behaviour and many are willing to pay more for sustainable transport options that are compatible with their values, such as electric vehicles. Users' interest in sustainability is also changing the way companies do business. Businesses are making commitments to less carbon-intensive fleets, setting internal emissions reduction targets and investing in renewable energy to power their operations.

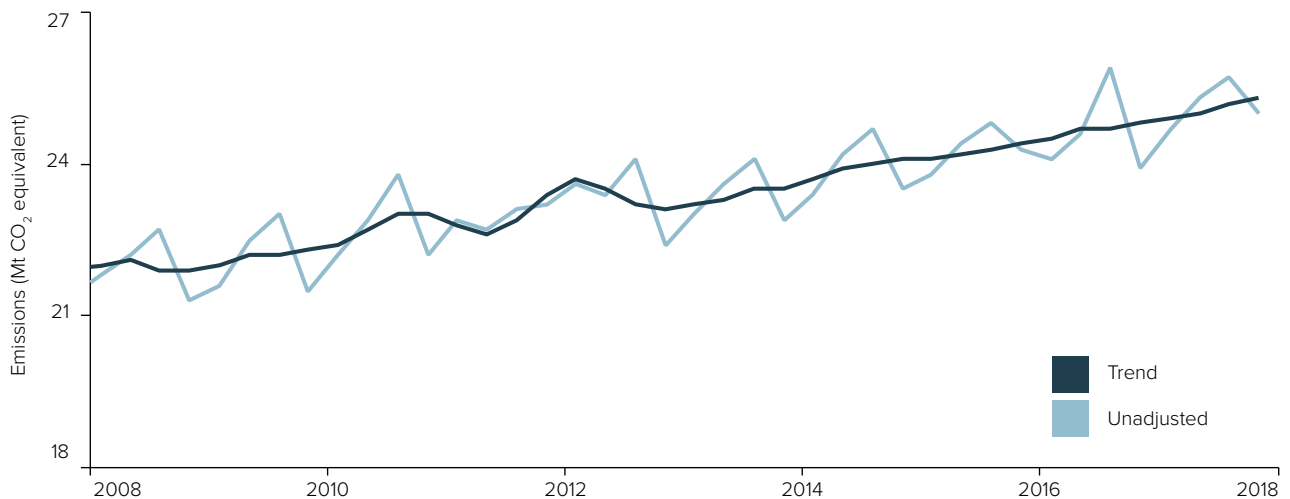
Passenger transport has a large and growing emissions footprint

The transport sector is the second largest source of Australian greenhouse gas emissions, at 19% of total emissions.¹⁷⁵ Transport emissions have grown faster than any other sector, increasing by around 60% since 1990.¹⁷⁶ Problematically, transport emissions are growing at a time when our nation is focused on reducing emissions from any and all sources (Figure 13).

Australia has one of the most emissions-intensive transport sectors in the world. There is considerable scope for our passenger transport sector to play its part in helping Australia meet its emissions reduction obligations.

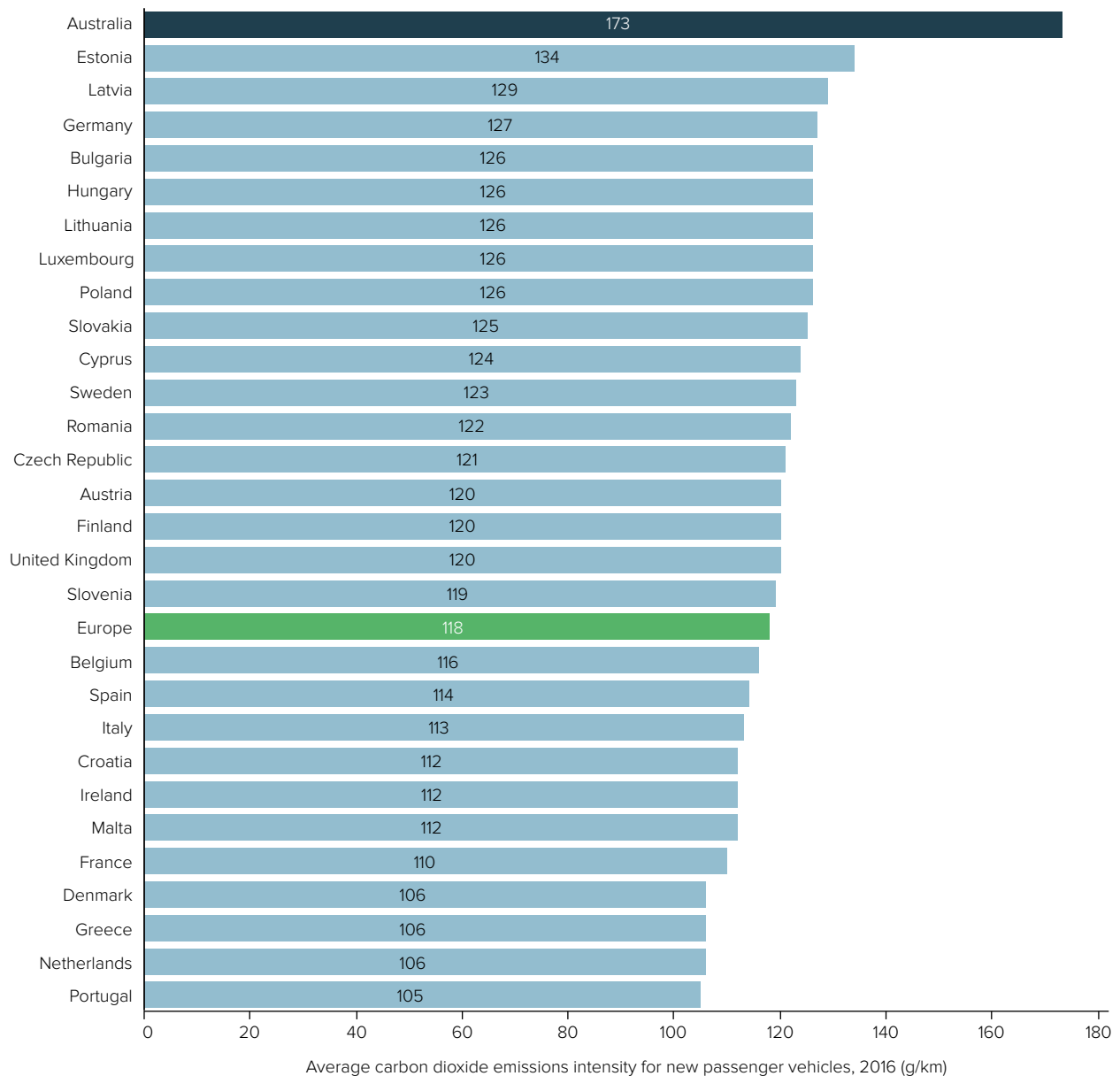
The emissions intensity of Australian transport networks is largely attributable to our reliance on private vehicles. Most Australians use their car as their primary mode of transport. In regional, rural and remote areas, users often have no other option. For this reason, 90% of non-capital city commuters use a private vehicle to get to work.¹⁷⁷ Our vehicles are some of the most emissions-intensive in the developed world (Figure 14). Due to Australia's car dependence and the emissions standards of our vehicles, passenger vehicles represent 46% of all transport emissions (Figure 15).¹⁷⁸

Figure 13: Transport emissions have been growing

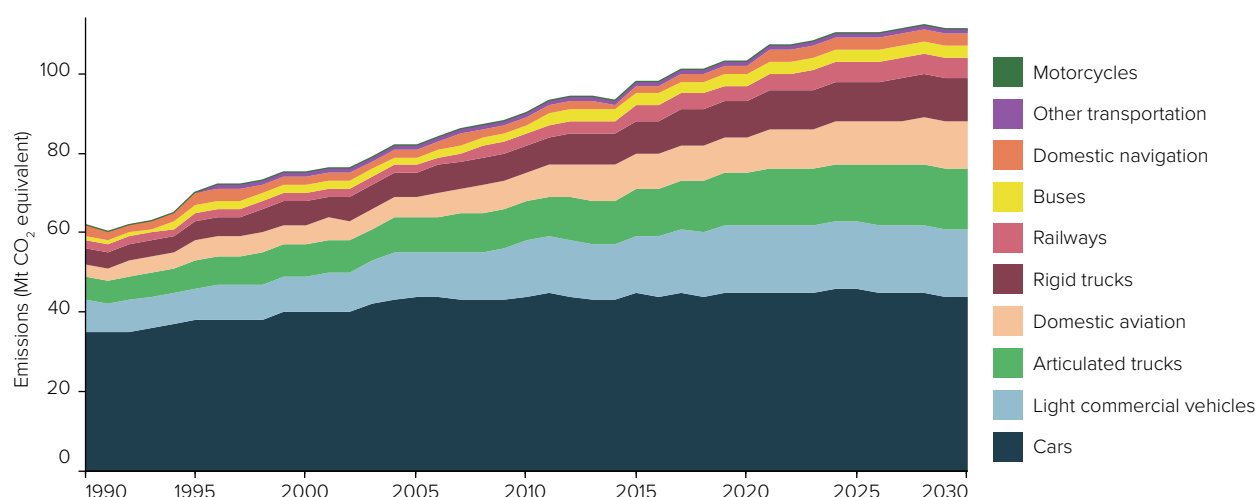


Source: Department of the Environment and Energy (2018)¹⁷⁹

Figure 14: Australia's new passenger vehicles are more emissions intensive compared to Europe



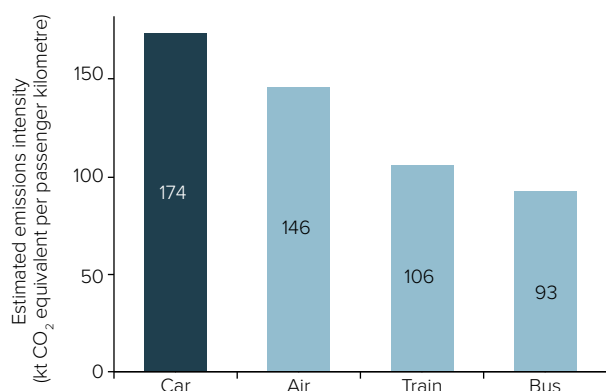
Source: National Transport Commission (2018)¹⁸⁰

Figure 15: Cars' total emissions are far higher than other modes of passenger transport

Source: Department of the Environment of Energy (2017)¹⁸¹

For the last ten years, the share of emissions from cars has been relatively stable despite increases in total vehicle kilometres travelled. This is due to improvements in fuel efficiency and the emissions ratings of new vehicles. However, projected emissions to 2030 indicate that these improvements are not enough to offset the growth in emissions from other transport modes. Specifically, emissions from articulated and rigid trucks, as well as light commercial vehicles, are expected to account for a growing share of the transport sector's total.

Existing technology offers the opportunity to reduce the emissions intensity of passenger transport. Mode shift away from private vehicles to public and active transport use, for example, could significantly reduce emissions. On average, public transport modes are less emissions-intensive than private cars, with well-patronised train services being the most efficient motorised passenger mode by this measure (Figure 16).

Figure 16: Private vehicles are more emissions intensive than public transport

Source: Bureau of Infrastructure, Transport and Regional Economics (2018)¹⁸⁵

However, car use can also have a reduced impact in this respect, through the introduction of stronger vehicle emissions standards, the greater uptake of electric vehicles, and measures to incentivise higher levels of vehicle occupancy through ridesharing schemes.

Cars are not the only large source of Australian passenger emissions. Emissions from the aviation sector have grown strongly as domestic and international air travel has become cheaper and more accessible. In the past decade, the number of annual passengers on domestic flights has increased from 50 million to 63 million.¹⁸² As a result, the civil aviation sector contributed more than 2% of Australia's emissions over that period.¹⁸³ While aircraft are becoming more fuel efficient, it has not been enough to offset the growth in air traffic. CO₂ emissions from domestic aviation are expected to be 40% higher in 2030.¹⁸⁴



58. Challenge

Transport sector emissions are increasing. Passenger cars account for the vast majority of emissions, but heavy vehicles and aviation are projected to drive growth in emissions in the next ten years.

Without action, the emissions intensity of passenger transport may cause negative environmental impacts and Australia will fail to meet its emissions reduction targets.

When this will impact:



Where this will impact:



Transport activities can have detrimental effects on our personal health

As well as greenhouse gas emissions that contribute to the global impact of climate change, the Australian passenger transport sector produces other airborne pollutants that have an adverse impact on localised air quality and human health outcomes. Additionally, the greater use of sedentary transport modes, especially driving, and associated reduced rates of active transport use have been shown to be damaging to personal health and wellbeing.

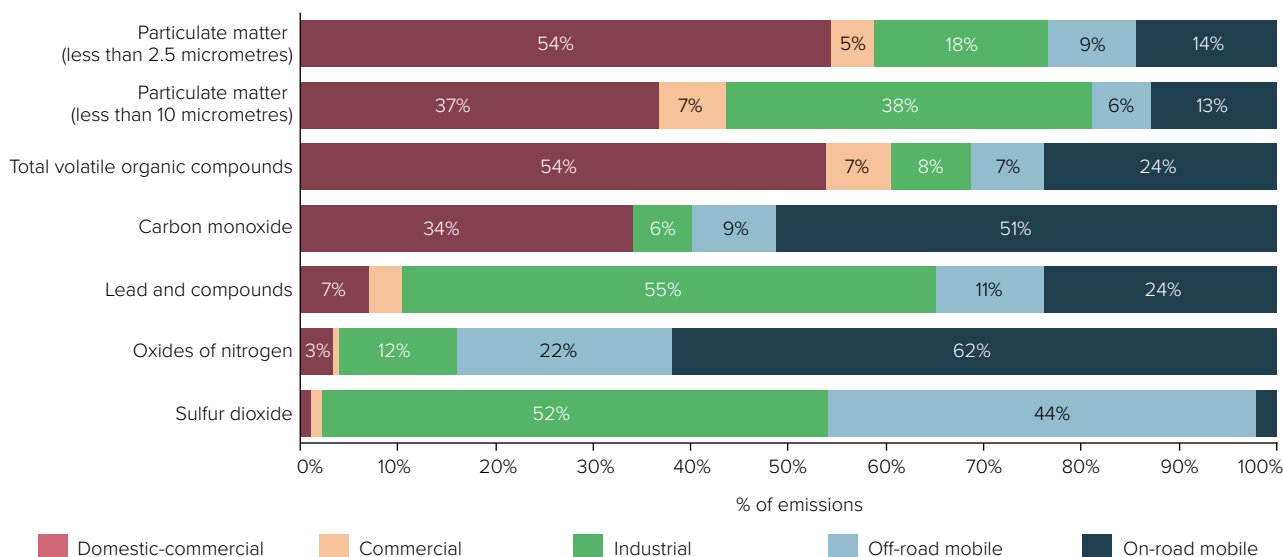
The negative impacts of transport on air quality are largely due to our reliance on petroleum. Petroleum powers internal combustion engine vehicles, aircraft and some public transport. It creates airborne

pollutants, including particulates, that can be harmful to our health and damaging to our ecosystems.

While Australia's air quality is good by international standards and advancements in vehicle efficiency standards have helped to reduce pollutants and emissions, an estimated 3,000 deaths in 2007 were caused by urban air pollution.¹⁸⁶

The transport sector is a major contributor to urban air pollution. For example, in Sydney 61% of nitrogen oxide emissions are attributed to motor vehicles.¹⁸⁷ Figure 17 shows air pollutant emissions by source for Sydney in 2008.¹⁸⁸ This pollution tends to be concentrated around major road corridors,¹⁸⁹ posing a health challenge for cities seeking to encourage denser development in central areas where traffic levels can be most intense.

Figure 17: The transport sector (classified as off-road and on-road mobile) is a major contributor to poor air quality



Source: Department of the Environment and Energy (2016)¹⁹⁰



Maritime and non-road passenger transport, such as diesel locomotives and cruise ships, also contribute to air pollution. These emissions are largely unregulated in Australia, although concerns about cruise ships, which use heavy fuel while they are docked, have already resulted in restrictions on these vessels in Sydney Harbour. As a further precaution, sulphur fuel restrictions will apply to all vessels from 2020.¹⁹¹

In terms of human health, there is also a large and growing body of evidence regarding the costs of physical inactivity in Australia, and the personal and social benefits of using active transport over sedentary modes.¹⁹² This especially applies to train or bus travel which generally includes a walking or cycling trip to access the public transport stop. A significant percentage of car trips in Australian cities are shorter trips that are within cycling or even walking distance.¹⁹³ Changes in travel patterns and expectations which have over time led to active transport being used for such trips impact personal health outcomes in areas including cardiovascular disease,¹⁹⁴ mental illness,¹⁹⁵ and childhood obesity.¹⁹⁶

Achieving further reductions in the health costs of passenger transport to our community will require more concentrated effort from Australian governments.

Transport sustainability goals are often not achieved

Governments often have ambitions to achieve transport sustainability goals, such as reducing private vehicle use. However, outcomes may not deliver on these aspirations. Expediency and siloed decision making can compromise the sustainability objectives outlined at a project's inception.

Policy-makers need to get better at translating goals into actions and developing their strategic approach. Reports such as *Sydney's Walking Future* help to cement strategic goals.¹⁹⁷ These reports can act as a point of reference for infrastructure decision-makers to prioritise public and active transport.

The private sector also has a role to play in ensuring our infrastructure is built sustainably. Increasingly, industry is adopting stricter standards which helps to achieve a more sustainable built environment.

Long-term sustainability planning is particularly important in our cities, which still have a large car mode share, low-density urban settlement patterns and growing populations. The Climate Council has indicated that cuts to emissions in cities could deliver up to 70% of the nation's required reductions under the Paris Agreement.¹⁹⁸



Reductions in car mode share can be accelerated by having more compact cities with high-quality, affordable transport systems. In Tokyo and Seoul, over 75% of journeys are on public or active transport.¹⁹⁹ These cities have used land-use planning to deliver high-density suburbs and encourage mode shift away from private vehicles, while meeting the day-to-day needs of users for accessibility and connectivity. Denser cities boost public transport patronage, allowing operators to run more efficient, frequent and higher-quality

services for users. The sustainability of our road network is also linked to its efficiency. Less fuel is used and less pollution produced per vehicle on free-flowing routes. The avoidance of congestion is therefore desirable to reduce the health and environmental costs of transport. This could involve consideration of approaches that reduce vehicle use including demand management, use of higher productivity vehicles and emerging technology such as connectivity and automation.

Better standards can improve sustainability

The development of widely adopted standards has improved sustainability outcomes in the passenger transport sector. Standards can deliver sustainability and resilience benefits at low costs to users by guiding design and lifecycle decisions. Some of the organisations assessing assets and providing ratings include the Infrastructure Sustainability Council of Australia, the Global Real Estate Sustainability Benchmark and the Green Building Council of Australia.

These ratings provide a benchmark for project design and lifecycle decisions that reduce carbon use and waste, save water and promote high-quality environments. The adoption of these

guidelines is contributing to better sustainability outcomes on passenger transport projects, such as the Flinders Street Station Upgrade and Sydney Metro Northwest tunnels. Many project developers are voluntarily adopting these standards, to build community goodwill and avoid expensive future retrofits.

How buildings are designed and constructed also has a bearing on the transport network's sustainability. This is why the Green Star rating system takes into account a building's access to public transport, active transport facilities, low-emissions vehicle infrastructure and supply of car parking.

59. Challenge

Australian governments often do not incorporate sustainability or resilience into their final infrastructure projects. Without regular action, active and public transport modes will be underutilised and our infrastructure will be less resilient and sustainable.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:





Emerging technology could reduce transport's impacts

Cars will continue to be an important part of Australia's passenger transport system. It is therefore critical to cost-effectively roll out new technology that can reduce the emissions and air pollution intensity of private vehicles.

New, more sustainable technology is driving changes in the transport sector.²⁰⁰ Passenger rail and tram networks in our major cities are already electrified. However, a transition in our bus and light vehicle passenger fleets from internal combustion engines to hybrid electric, plug-in electric, hydrogen fuel cell and automated vehicles could deliver even greater emissions reductions.

Hydrogen and electric vehicles' emissions are based on where they source their electricity. Recharging an electric vehicle from the renewables-dominated grid in Tasmania would cause far fewer emissions than an electric vehicle powered by the coal-dominated Victorian system. It is likely that most users will source their electricity from the grid rather than from a local source such as domestic solar panels due to the high volume of electricity required to charge

an electric vehicle. At present, an average new internal combustion engine vehicle emits 185g CO₂ per kilometre, while an average electric vehicle – when recharged from the grid – around 98g of CO₂ per kilometre.²⁰¹

It is unclear whether automated vehicles will have an effect on emissions. Automated vehicles using efficient routes and carrying multiple customers could reduce emissions and save energy compared to current travel patterns. These vehicles will be designed to drive in close proximity to each other, reducing drag. However, in a scenario where the availability of driverless cars increases vehicle kilometres driven, this technology could increase Australia's emissions footprint.

A sustainable transport sector also requires that attention be paid to the whole-of-life impacts of new technology. For example, each electric vehicle purchased will contain a lithium-ion battery. As the mass market for electric vehicles develops, the number of lithium-ion batteries will dramatically increase in Australia, and we will need methods of sustainably disposing of, reusing or recycling these assets.

60. Opportunity

If partnered with low carbon intensity fuels hybrid electric, plug-in electric, hydrogen fuel cell and automated vehicles are less emissions intensive than internal combustion engine vehicles. These technologies can be leveraged to transition to a low-carbon transport sector. Reducing transport sector emissions would help Australia meet its international obligations while also improving local air quality.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Increasing the resilience of transport networks is challenging for governments

Alongside sustainability, planning for a more resilient transport sector will be vital to Australia's economic strength and liveability. Our transport infrastructure faces major threats from extreme weather events, inadequate maintenance, accidents, terrorism and cyberattacks.

As the populations of our fast-growing cities increase, so too do the consequences of disruption. Even minor incidents can cause large disruptions and be costly for users and taxpayers. For example, in 2018, the disruption caused by a single morning peak-hour incident on the Sydney Harbour Bridge was estimated to have had an economic cost of \$5 to \$10 million.²⁰²

Major disruptions will occur in a future where severe weather events are more frequent and more damaging. Changes in climate and extreme weather events cause damage to transport assets and prevent communities from being able to carry on their day-to-day lives or businesses. It is estimated that the January 2009 heatwave in Melbourne resulted in financial losses of approximately \$800 million, primarily due to electricity outages and transport network disruption.²⁰³

Risks to our network are not evenly distributed. Each geographical area will face its own challenges and will require different investments. In cities, higher instances of extreme heat events can damage roads and shut down rail networks, while carbon dioxide can slowly accelerate the deterioration of concrete.²⁰⁴ Regional areas, which are heavily reliant on major highways, can face major disruption due to floods and bushfires.

Rural and remote communities need transport access for necessities such as food and fuel, but have to deal with the accelerated deterioration of road pavement through heat wear or flood damage, which can require additional urgent repairs. In October 2016 the Newell Highway was closed for six weeks between West Wyalong and Forbes in central western New South Wales due to flooding. This resulted in increased road freight transport costs, losses in tourism expenditure and agriculture production, and increased road maintenance expenditure along the highway itself and key detour routes.

Our passenger transport network will have to adapt to new circumstances while limiting disruption to its function. Weather-related risks to transport assets and services, and their interdependency with other types of at-risk infrastructure such as the electricity grid, need to be understood and managed. Preparing transport infrastructure and services to be more resilient will minimise the consequences of asset and service failures, reducing costs and improving access for users. The longer these resilience upgrades are delayed, the more they are ultimately likely to cost.²⁰⁵

However, an excessively risk-averse approach could overestimate the probability or severity of risks, resulting in over-investment in assets. This could result in the costs of mitigation exceeding an efficient and balanced approach. Transport users and taxpayers would wear the costs of unnecessary investments. A balanced approach will require a focus on measures that minimise the effects of extreme weather, while considering the costs of providing additional infrastructure.

61. Challenge

Climate change is likely to cause increasingly frequent and severe weather events that damage transport assets. Without resilient infrastructure, network functionality could be limited and the costs of upgrades could be more substantial.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



5.7 Safety in the transport sector

At a glance

Recent trends show we are unlikely to meet our targets for reducing road crashes and fatalities. These are costing us \$30 billion a year, causing social trauma and affecting user behaviour.

This section discusses how infrastructure solutions can improve our safety outcomes, particularly for the users most at risk. It also looks at the cybersecurity risks that come with new technology.

Road fatalities are declining, but still not meeting reduction targets

In 2018, 1,226 Australians were killed and around 36,000 hospitalised following a road crash.²⁰⁶ This road trauma is estimated to cost the Australian economy \$30 billion annually.²⁰⁷ More than just financial costs are felt. Crashes cause trauma for families and local communities, and can change how users interact with their transport networks, often at the cost of more efficient, affordable and sustainable transport options.

In 2011, the National Road Safety Strategy was developed in response to Australia's unacceptably high fatality rate. The strategy is based around a multidimensional Safe Systems Approach that aims for safer vehicles, safer behaviour, safer speeds and safer roads. The strategy recognises that road users will make mistakes – but the road system should be forgiving, so that a mistake does not result in death or serious injury.

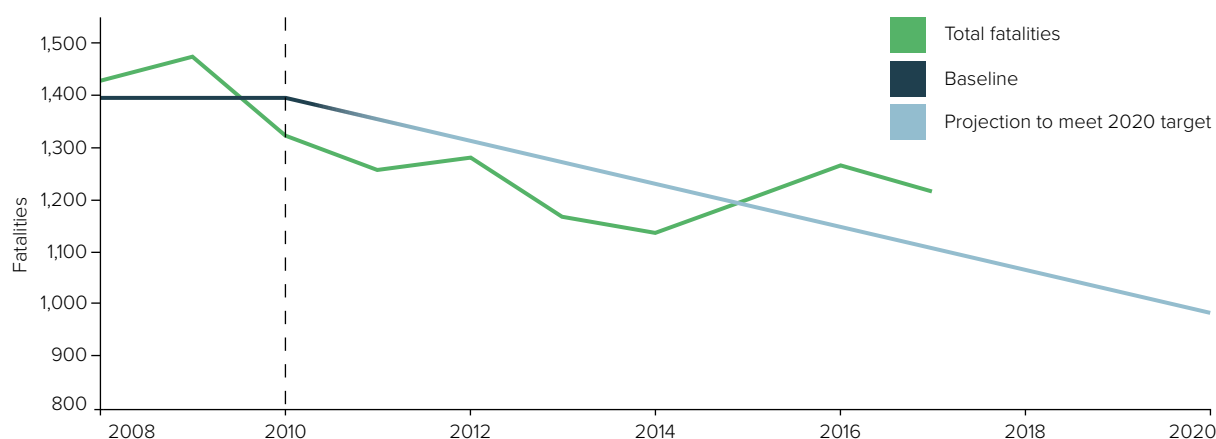
The National Road Safety Strategy aimed for a 30% reduction in road crash fatalities between 2010 and 2020. As of 2017, there has only been a 14.1% reduction.²⁰⁸ While passenger car deaths have decreased at the fastest rate since 2010, they still account for 60% of all road deaths in Australia.²⁰⁹

Motorcyclist and pedal cyclist fatalities have seen no improvement.²¹⁰ In 2015-2016, there was even an increase in road fatalities. This suggests that the nation's road safety performance may even be stalling, as shown in Figure 18, and foreshadows a challenging review process when jurisdictions renegotiate the National Road Safety Strategy.

A lack of reliable, consistent data across all levels of government makes it difficult to identify all of the reasons for the increase in fatalities in the 2015-2016 period. Without data on injury incidence and crash causes, there are gaps in our knowledge about the road system's safety performance. Appropriate infrastructure and policy responses require robust and reliable data. An accurate and consistent evidence base is also important as the road network adapts to changes in its use.

One known reason for the increase in fatalities in 2015-2016 is the effect of driver fatigue and distraction. From 2013 to 2017, more people died in New South Wales fatigue-related crashes than drink-driving crashes.²¹¹ The use of mobile phones accounts for at least 2% of all fatal crashes involving distraction,²¹² although this factor is under-reported due to strong disincentives against self-admission and the absence of witnesses to single vehicle crashes.²¹³

Figure 18: Fatalities are decreasing, but not fast enough to meet our 2020 target



Source: Bureau of Infrastructure, Transport and Regional Economics (2018)²¹⁴

Infrastructure plays a critical role in road safety outcomes

The Safe Systems Approach aims to ensure that, when a driver makes a mistake, it will be unlikely to result in a crash. Road infrastructure can support this outcome. To do this requires cost-effective allocation of Australian Government, state and territory, and local government funding. Road safety funding is significant. For instance, the Australian Government provided \$744.5 million to the Black Spot Program from 2013-14 to 2021-22.²¹⁵ To spend funds efficiently, there needs to be identification, assessment and prioritisation of high-risk sections of the transport network. Tools such as AusRap's national network rating are useful.²¹⁶ However, more data would reduce inefficient capital-intensive safety investments.

States and territories have implemented a variety of low-cost infrastructure safety solutions. South Australia, New South Wales, Victoria and Tasmania have installed wire rope barrier systems. Western Australia has installed audio-tactile markings.²¹⁷ Simply reducing the speed limit on a high-speed road can also result in a reduction of over 30% in serious and fatal injuries.²¹⁸ Speed limits are more effective when supported by infrastructure such as point-to-

point speed cameras and mobile speed cameras. Point-to-point speed cameras could reduce deaths by 49%.²¹⁹ Progress in the use of point-to-point speed cameras has stalled, in terms of their limited enforcement hours, slow roll-out and use at few locations.²²⁰

Our road infrastructure investments need to strike an appropriate balance between safety, productivity and liveability. For example, while reducing speed limits to 30 km/h in dense urban areas can increase safety for pedestrians,²²¹ this approach is not likely to be suitable for freight routes of importance to national productivity. A selection of appropriate road safety policies should be balanced across the needs of all road users, the economy and the liveability of our communities.

There is also an opportunity to prepare our road infrastructure for the safety technology of the future. In itself, technological innovation which is making vehicles safer, such as automation, will not deliver safer roads. That outcome will be dependent on investment in the machine-readable road infrastructure and communications components which advanced technology vehicles are likely to depend on, such as line markings, road signage and smart poles.

62. Challenge

Road safety performance is not on track to meet the objectives of the National Road Safety Strategy. Without action road users will continue to be vulnerable and at risk of serious injury or fatality.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



63. Challenge

Project selection and funding is based on incomplete safety data. Without action, this will inhibit effective cost allocation and understanding of trade-offs with other transport outcomes, such as productivity.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Regional, rural and remote road users are at greater risk

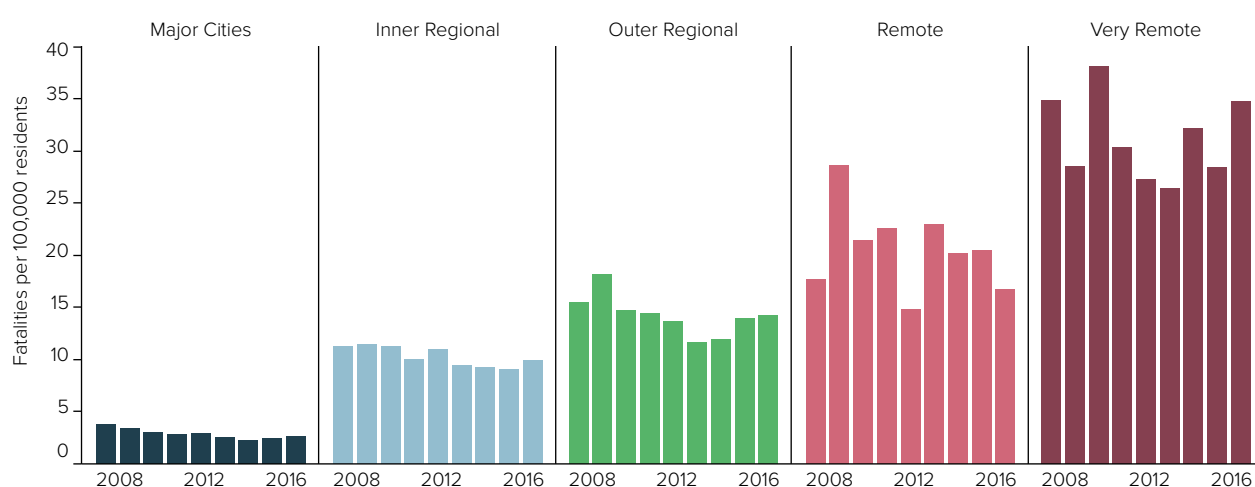
Regional, remote and rural road users face a higher risk when they travel on their local roads. Figure 19 shows that a disproportionately higher rate of fatalities occurs in regional or remote areas. Up to 65% of total road deaths occur in sparsely populated regional and remote areas.²²² Most fatal crashes occur on a stretch of road with a speed limit over 100 kilometres per hour.²²³

Regional communities have low population density and extensive, low-quality road networks with high speed limits. Lower safety standards are not the result of the poor performance of local governments,

but the inevitable consequence of service provision to a relatively small number of people spread over a large area. As a result, there are challenges to maintaining, upgrading and renewing ageing assets, and achieving the rising standards associated with other parts of the road network. While local governments manage roads, all three levels of government, the community and the private sector hold levers to reduce regional road crashes.

The 2019 *Infrastructure Priority List* has identified regional safety improvements as a high-priority initiative. The initiative recognises the need to continue to identify, assess and prioritise high-risk sections of regional roads across Australia.²²⁴

Figure 19: Fatalities occur at a disproportionately higher rate in regional or remote areas



Source: Bureau of Infrastructure, Transport and Regional Economics (2018)²²⁵

64. Opportunity

Regional, rural and remote road networks are less safe. There is an opportunity to focus investments and policies on these areas. Identifying, assessing and prioritising sites for upgrades and road treatments on high risk corridors could optimise investment and reduce fatalities.

When this will impact:



Where this will impact:



An older vehicle fleet makes it difficult to embrace new safety technology

Australians are driving their cars for longer. The average age of the Australian fleet has risen from 12.5 years in 2014 to 13.1 years in 2016.²²⁶ As a result, many Australians are driving cars that do not meet best-practice safety standards. This has implications for safety outcomes. Vehicles aged over 15 years are four times more likely to be involved in a crash than vehicles aged five years or less.²²⁷

Increasing vehicle safety standards reduces road crashes. Users are five times more likely to be killed or injured in an Australasian New Car Assessment Program (ANCAP) one-star car than in an ANCAP five-star car.²²⁸ Road safety standards ensure that Australians are given access to safe vehicles. The proportion of ANCAP five-star vehicles in the Australian fleet increased from 76% in 2013 to 91% in 2017.²²⁹ Since every vehicle imported and sold can have a life of 30 years or more, safety standards have long-term implications.

While vehicle safety features are important for keeping users safe, human error still causes 94% of road crashes.²³⁰ Vehicle connectivity and automation technologies can reduce the risk of human error in the short term and eliminate it over the long term. Automated vehicle technology is already included in many Australian vehicles, including auto emergency braking, lane-keeping assist, adaptive cruise control and intelligent speed assist. These safety innovations are helping to reduce rear-end crashes, prevent collisions during lane changing and maintain safe speeds.

Safety-oriented vehicle standards can have productivity and environmental impacts. Safety features often add weight to a vehicle, leading to the production of more emissions. Different users will have a different willingness to pay for such safety features, especially when they compete with other user values. It will be challenging to balance safety features against affordability, productivity and environmental concerns.

65. Challenge

Australians are holding on to their vehicles for longer. Older vehicles often do not meet modern safety standards and are more likely to injure or kill if involved in a crash.

When this will impact:



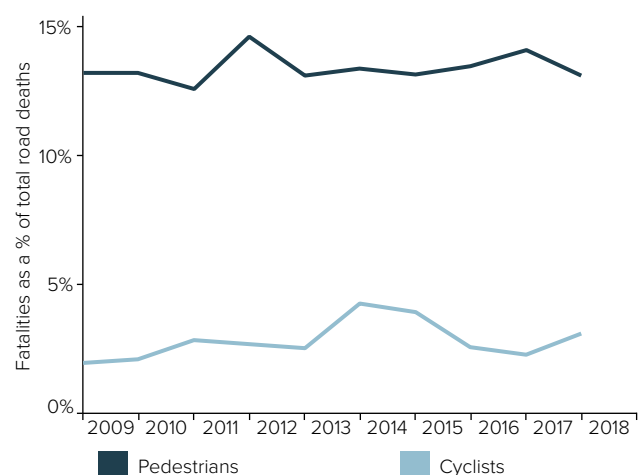
Where this will impact:



Pedestrians and cyclists are particularly vulnerable

Walking is Australia's most common transport mode. Most Australians start and/or end each longer journey on foot or a bicycle. Pedestrians and cyclists are vulnerable to crashes. In 2016, 182 pedestrians and 29 cyclists were killed in regional and urban areas of Australia,²³¹ and their proportions of all road deaths have not decreased over the past ten years (Figure 20).²³² Non-fatality crashes are even more common. In 2015, 9,352 pedestrians and cyclists were hospitalised.²³³ Transport networks should enable safe, affordable and efficient active travel, with pedestrians and cyclists using the network at their own pace.

Figure 20: The proportions of all road deaths by pedestrians or cyclists have not fallen in the past 10 years



Source: Bureau of Infrastructure, Transport and Regional Economics (2018)²³⁴

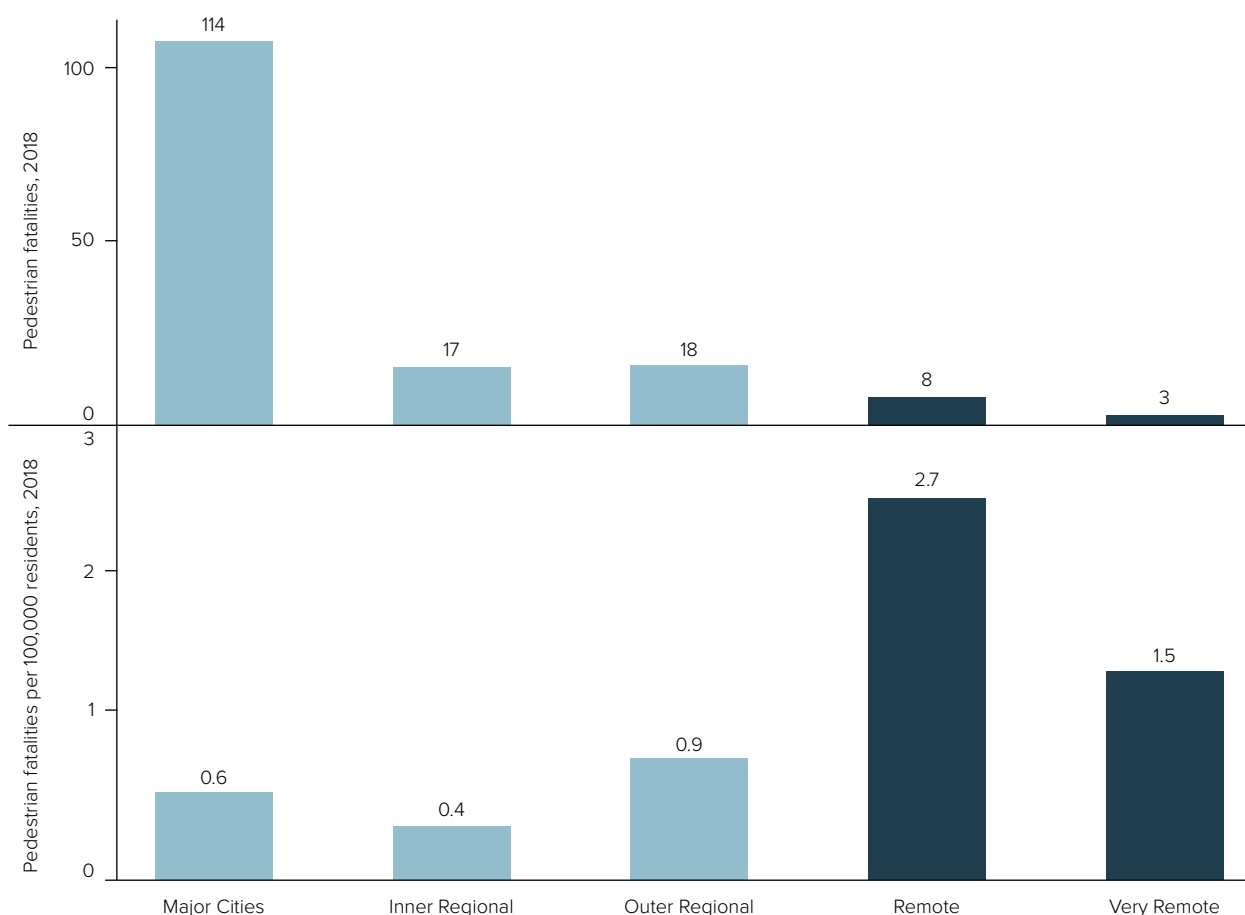
Pedestrian and cyclist safety is a countrywide issue. Thousands of people walk in the Sydney and Melbourne CBDs and other dense urban environments every day. These areas often do not prioritise non-motorised traffic. In regional, rural and remote areas, inadequate pedestrian and cyclist infrastructure results in even higher fatality and injury rates compared to metropolitan areas (Figure 21).

Female active and public transport users are particularly conscious of their vulnerability to assault, injury and confrontation with other transport system users.²³⁵ This feeling is most pronounced at night, when there is limited passive surveillance. One in four women do not walk alone in their local area after dark because they feel unsafe.²³⁶ Perceptions of safety on public transport are worse, with up to 23% of women not feeling safe if using public transport alone after dark.²³⁷ Perceived threats to personal security on the active and public transport network at night lead many to favour private transport. This shift in modes reduces the beneficial effect of more people being active in public spaces, further driving down active transport participation.²³⁸

Infrastructure and policy decisions can make active transport users safer. For instance, many older and vulnerable people find that crossing a road at traffic lights can be a stressful and dangerous experience. Traffic light timings that operate at 1.2 metres per second are often inadequate for older pedestrians who on average walk at 0.9 metres a second.²³⁹ In recognition of almost one quarter of pedestrian crashes in New South Wales occurring at signalised intersections, that state's councils have been considering more frequent and longer pedestrian crossing opportunities and crosswalk widening at major intersections.²⁴⁰ This could have large benefits in other areas, considering that people aged over 70 make up 33% of pedestrian deaths in Victoria.²⁴¹

Another proven method of limiting pedestrian and cyclist injuries and fatalities is to lower the speed limit (Figure 22). As such safety improvements can affect productivity and accessibility for other modes of transport, road design and management decisions need to strike an appropriate balance between safety, productivity and liveability.

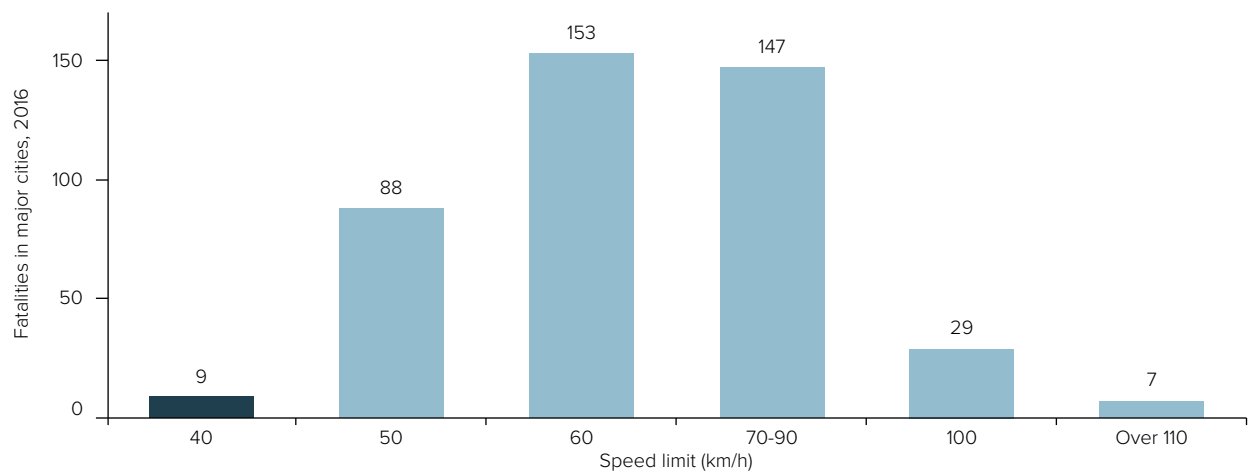
Figure 21: Pedestrian fatality rates are higher in regional and remote Australia



Source: Infrastructure Australia analysis of Bureau of Infrastructure, Transport and Regional Economics (2019) and Australian Bureau of Statistics (2019)²⁴²



Figure 22: The number of fatal crashes in 40km/h zones is much lower than in higher speed zones



Source: Bureau of Infrastructure, Transport and Regional Economics (2018)²⁴³

66. Challenge

Pedestrian and cyclist fatalities are over represented in fatalities and injuries. Without action, active transport users will continue to be injured and killed, and the attractiveness of active transport will remain low.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Cybersecurity is critical to transport's resilience

Australia's transport providers are transforming their businesses through the ever-increasing use of technology to provide better services to customers. Australians can access real-time information to find the most efficient mode of transport, calculate the cost and duration of travel, and book and pay for a service. Transport providers use this data to further understand customer needs and improve their offerings.

As the technological landscape changes, transport providers will have access to even more detailed consumer information. Technologies such as autonomous vehicles will need to transmit and receive huge volumes of data in order to function. Digital systems storing and moving data will be integral to the delivery of transport services.

Consumer and systems information is valuable to malicious external actors. For this reason, cyberattacks are becoming more advanced, frequent and targeted. The value of the data held within the Australian transport network is unknown. However, Transport for London has estimated that use of such

data contributes up to £130 million annually to that city's economy.²⁴⁴ This value is based on travel that is more efficient, the creation of high-value jobs and the reduction of transport operating costs.

A cyberattack can inflict financial or reputational damage on individuals and businesses. Additionally, cyberattacks are capable of causing operational failures such as train derailments or crashes, which can threaten the safety of entire transport networks. While safety concerns are paramount, all security incidents degrade customer trust. Privacy is increasingly hard to protect for citizens in a digital world.

The Australian Government released a national cybersecurity strategy in 2016, highlighting the need for national investment in this domain.²⁴⁵ The strategy aims to empower Australians with cybersecurity skills, while ensuring that Australia's networks and systems are resilient to attack. Tackling cyberthreats is key not only to protecting consumers' data and safety, but also to ensuring that Australia can benefit from step changes in technology. Estimates of the current level of investment in cybersecurity across our transport networks are not publicly available.

67. Challenge

Technological change is driving the collection of valuable data by transport operators and network owners. This information is valuable and can be vulnerable to cyberattacks.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



5.8 Transport accessibility and equity

At a glance

Many Australians lack equal access to transport, and the opportunities it opens up, due to financial, geographic, physical or cognitive restrictions. This section explores how these impact communities and the role played by infrastructure in addressing or compounding those challenges.

Our transport networks can do more to address social disadvantage

Not all Australians find daily travel simple, straightforward or affordable. People's experiences of using our transport networks vary across travel time, comfort and security outcomes, and in the level of disadvantage felt in relation to the affordability of tolls and fares, availability of services and physical accessibility.²⁴⁶

This section explores three common types of disadvantage:

- **Financial disadvantage** refers to people who experience financial stress. Transport is a key service, but its costs can sometimes be regressive, with those who are already financially stressed paying a greater proportion of their income to access the network and reach opportunities.
- **Physical and cognitive disadvantage** refers to people who have a mobility, sensory or cognitive impairment. Specifically, we focus on people with disability and older people.
- **Geographic disadvantage** refers to anybody who lacks access to transport because of where they live or work. This is a very broad section of the community, but it focuses on regional and remote Australians and people who live on the outskirts of our cities.

The section is split into the three common types of disadvantage for ease of analysis. However, it is important to acknowledge that some people experience greater levels of multiple disadvantage than others, and often issues of disadvantage are intertwined and can be compounded.

Outer-urban and regional communities are particularly at risk of transport disadvantage

Public transport plays a vital role in promoting social equity. Disadvantaged groups with limited access to public transport are especially at risk of social exclusion.

People living in outer-urban areas and regional centres often have poor access to public transport and rely heavily on private vehicles for access to jobs, education, services and entertainment.

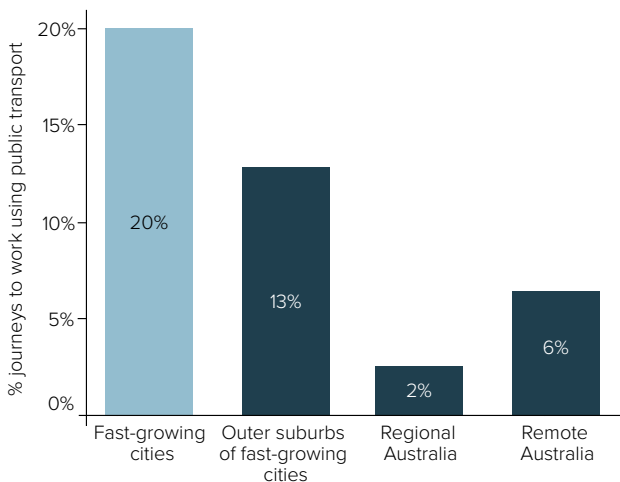
Outer-urban and regional centres encompass a broad range of communities, from the outlying suburbs of our major cities, which are integrated within the broader urban economy, to regional centres that may be supported by a surrounding agricultural or mining hinterland.

The transport needs and patterns within each area vary with context. However, governments and public transport operators often encounter common problems when delivering services to these areas. Lower residential and employment densities, combined with long distances and dispersed trip patterns, mean that public transport has traditionally struggled to provide sufficient service levels to compete with the private vehicle.²⁴⁷

There are three common challenges that outer-urban and regional communities face when seeking to use public transport:

1. **Access to public transport is lower.** Lower settlement densities mean people are less likely to live within walking distance of a public transport stop or station.
2. **Service frequencies are lower.** Operators can provide higher frequencies when there is sufficient demand. Demand is normally lower in outer-urban areas and regional centres, meaning frequencies are lower. This means people wait longer for services, and cannot interchange between services easily.²⁴⁸
3. **Travel distances are longer.** People living in outer-urban and regional areas tend to live further away from places of work, education, services and entertainment. For example, about 44% of people in outer-urban areas travel more than 20 km to work, compared to 7% of people in inner-urban areas.²⁴⁹

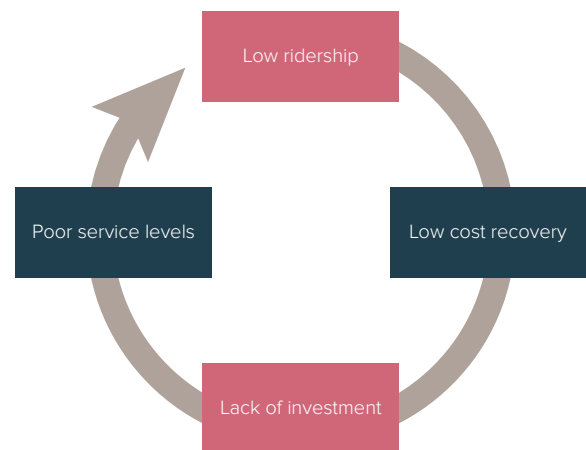
These challenges usually lead to lower patronage levels. Public transport use in the outer suburbs of our major cities and regional Australia is significantly below the average across our largest cities (Figure 23).

Figure 23: Fewer people use public transport in our outer suburbs, regional and remote Australia

Note: The outer suburbs is included in the average for the fast-growing cities. Boundary definitions for outer suburbs can be found in *Outer Urban Public Transport*.²⁵⁰ The majority of public transport use in remote Australia relates to people employed in the mining sector in Western Australia.

Source: Infrastructure Australia analysis of Australian Bureau of Statistics (2016)²⁵¹

It is common for public transport services in lower-density environments to get caught in a self-defeating cycle. Existing services are poorly patronised, so governments do not invest in new infrastructure and improved service levels. This leads to poor performance, which further discourages partnership and cost recovery (Figure 24). Compounding this cycle in outer-urban areas where new communities are in an early stage of development, residents' natural response to poor public transport service levels is to buy more cars and drive instead. This embeds car dependence so that, even when communities grow to a size and density that might support reasonably frequent public transport services, it can be too late and costly to introduce these and induce people to switch from driving.

Figure 24: Outer-urban public transport is caught in a cycle of poor performance and service levels

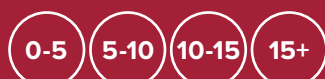
Source: Infrastructure Australia (2018)²⁵²

The challenge for governments is to find ways to escape this cycle. There is an opportunity for public transport operators to utilise emerging technology to fill the gaps where traditional public transport has struggled. Infrastructure Australia's recent paper, *Outer Urban Public Transport: improving accessibility in lower density areas* discusses how emerging modes such as rideshare, carshare and on-demand buses could help to better serve people living in outer-urban and low-density areas.

68. Challenge

Public transport service levels and access is lower in the outer suburbs and regional centres. This results in lower public transport mode share, and a reliance on cars in these areas. Without action, people who live in these areas will continue to be reliant on their cars.

When this will impact:



Where this will impact:



Transport makes up a large portion of household costs

Every household must pay to access key infrastructure and its cost can contribute to financial stress. In recent years energy costs have increased substantially and have become a key cause for concern. However, although energy has arguably experienced more attention in recent years, the cost of transport remains the largest single component of people's infrastructure bill.

In 2015-16, the average Australian household paid about \$205 per week for transport, or 14.3% of total household expenditure, compared to \$41, or 2.8% of total household expenditure, for energy (Figure 25).²⁵³ While the costs of transport peaked as a percentage of household expenditure in 2009-10, they have still grown in real terms between 2003-04 and 2015-16.

The cost of using public transport has grown on average by 11% between 2003-04 and 2015-16.²⁵⁴ However, the effect of this has been more than offset by reductions in the purchase costs of new vehicles, which decreased by 19.8% from 2003-04 to 2015-16.²⁵⁵

Transport costs are often higher in isolated suburbs within cities, as well as remote areas, which may overlap areas with lower average incomes. In the outer suburbs of our major cities, people generally rely more on their car than their counterparts in the inner city. This is likely because public transport is less accessible and lower quality in the outer suburbs than the inner suburbs, with services further away, less frequent, longer in reaching key destinations, slower and less reliable.²⁵⁶

As a result, overall the real costs of transport are higher in the outer suburbs (Figure 26). The cost of operating a vehicle is the key point of difference, with expenditure on fuel, lubricants and additives

significantly higher in outer-urban areas faced with longer journeys to access work and services. The difference between inner and outer suburbs is even greater when calculated as a proportion of household expenditure.

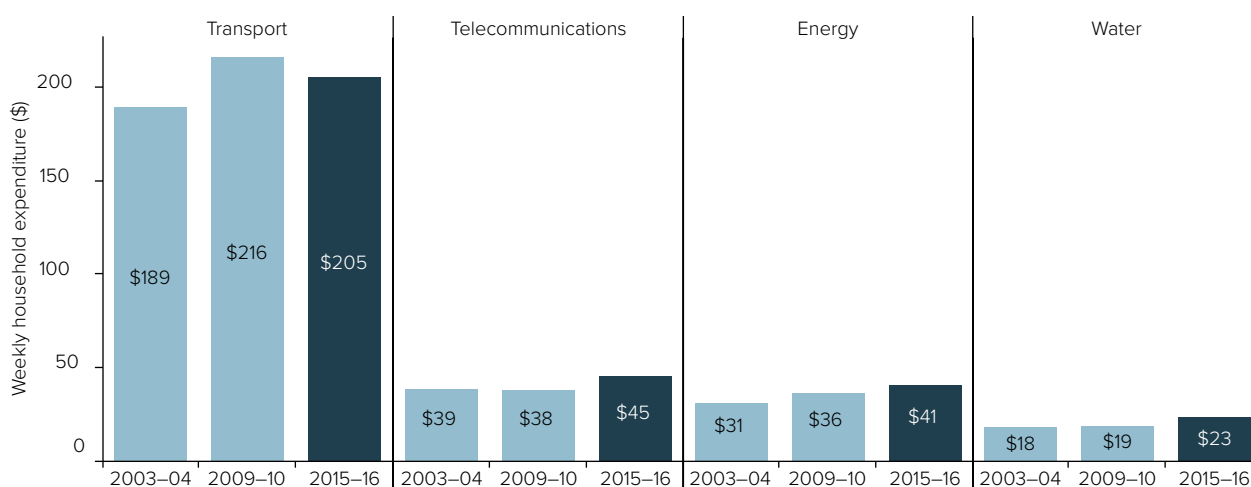
Transport in regional and remote Australia is very different to our major cities. Costs outside major cities (classified as 'rest of state') can be lower overall. However, in dollar terms this is largely because of low public transport use and an absence of parking fees and road tolls. The cost of operating a vehicle, such as fuel and vehicle parts and servicing, is higher on average than in the inner and middle suburbs of major cities.

However, when presented as a percentage of total household expenditure, the transport costs experienced outside capital cities constitute a heavier financial burden than in any other geographic area. Australians living outside our capital cities spend a greater share of their income on transport than anyone else.

Another important aspect of travel in regional and remote Australia is air travel. Distances in regional and remote Australia are immense, which often means flying is the only viable choice. Aviation is especially important for remote communities, as it can be the key link to important services such as healthcare, to economic opportunities and to family. It can be critical to perceptions about the connectivity and liveability of a region.

The cost of regional airfares relative to fares paid for higher-volume intercity routes has been a focus for governments in recent years. A Western Australian parliamentary inquiry submitted its report into regional airfares in late 2017, and a Commonwealth parliamentary inquiry is due to report in June 2019.

Figure 25: Transport contributes the greatest to household infrastructure costs



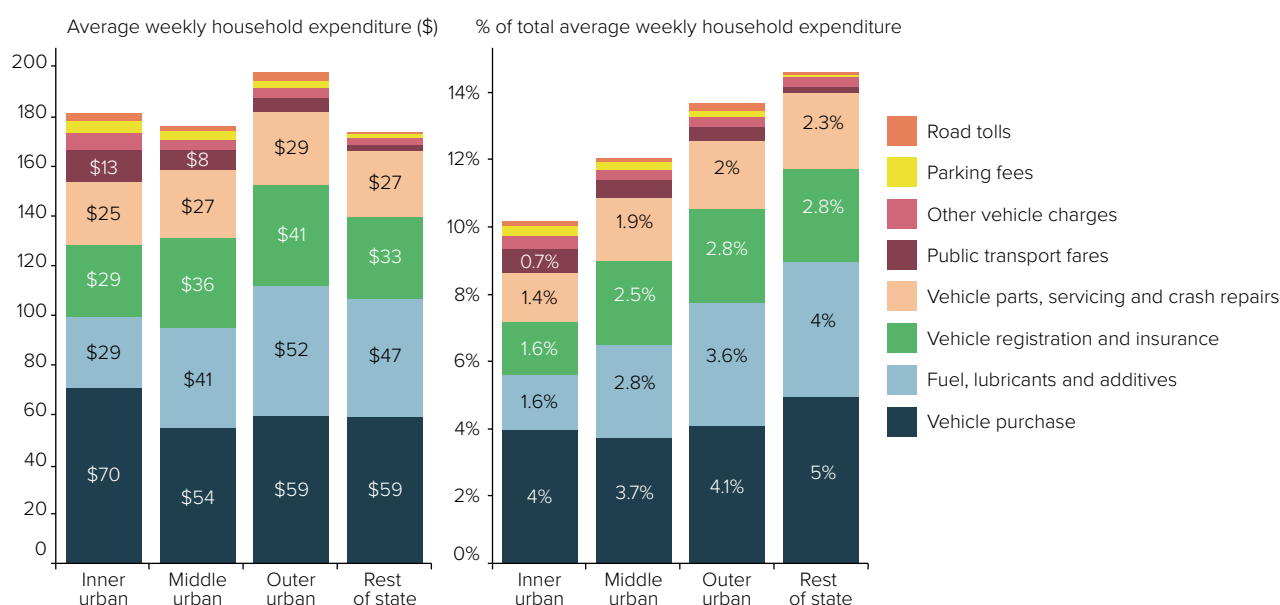
Note: Values are inflation adjusted to June 2016.

Source: University of NSW City Futures Research Centre and Astrolabe Group analysis of Australian Bureau of Statistics (2019), Bureau of Meteorology (2019)²⁵⁷

Data on regional and remote airfares need to be analysed with care because each route represents a market for private aviation operators. In other words, pricing will usually be determined on a case-by-case basis, subject to the commercial considerations of airlines. This means that data regarding pricing mechanisms and structures are commercially sensitive and difficult to access. Comparing average prices can also be problematic because of the variability in pricing over short periods of time and the fact that some regional air routes are regulated, which usually means their operator is granted a monopoly over a route and prices cannot exceed an agreed fare.

Despite the paucity of data, there are community perceptions that regional and remote airfares are too high.²⁵⁸ This is particularly the case for airfares on unregulated routes, where a government has left prices to be determined by operators.²⁵⁹ Airlines have acknowledged that flying to smaller population centres comes with high operating costs. A larger number of passengers offers potential economies of scale, e.g. improving aircraft utilisation and allowing for larger and more efficient aircraft with lower per-passenger operating costs.²⁶⁰ For unregulated routes, customers ultimately pay the higher costs of serving smaller communities.

Figure 26: Household expenditure on transport is higher in the outer suburbs of our major cities



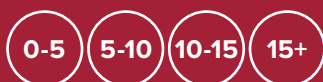
Note: These averages are for New South Wales, Victoria, Queensland, Western Australia and South Australia only. Inner-, middle- and outer-urban boundary definitions can be found in *Outer Urban Public Transport*.²⁶¹

Source: Infrastructure Australia analysis of Australian Bureau of Statistics (2017)²⁶²

69. Challenge

People on the outskirts of our cities and in regional and remote Australia pay proportionally more for transport. Unless addressed, our transport networks will continue to be inequitable, with people in the outer suburbs and regional and remote Australia paying proportionally more.

When this will impact:



Where this will impact:



Transport services are critical for people with disabilities and older people

Many Australians find daily travel a challenging task. For older people and those with disability, using active transport, public transport, on-demand services or a motor vehicle can be difficult or painful, or take a lot of time.

Over four million Australians have a disability, meaning that they have a limitation, restriction or impairment which has lasted or is likely to last six months and restricts everyday activities. Unsurprisingly, disability rates vary with age, with about 12% of people between 35 and 44, and over 85% of people over 90, reporting a disability.

There are, of course, a broad range of disabilities. Close to 6% of Australians have a profound or severe disability, which means they sometimes or usually require assistance to undertake core tasks (mobility, self-care and communication).²⁶³

Transport is a key enabler for people. It allows them to access work, leisure, education and healthcare services. Older people and those with disability are particularly vulnerable, and are at greater risk of experiencing social isolation and loneliness. They are also more likely to require frequent access to healthcare services.²⁶⁴ Transport is therefore critical, because it helps some of our most vulnerable community members access the services they need to live healthy and fulfilling lives.

Public transport accessibility has improved, but will likely fall short of goals

In 2002, the Australian Government introduced Disability Standards for Accessible Public Transport (the Standards), requiring public transport to be fully accessible by 2022 and passenger trains and trams to be fully accessible by 2032.²⁶⁵

The Australian Government Department of Infrastructure, Transport, Cities and Regional

Development reviews the Standards every five years. It is currently reviewing progress against the legislation's 2017 checkpoint, which requires 80-90% of services to meet the Standards.

Although individual agencies and local governments report advances in accessibility annually, often against goals set out in an accessibility plan, this reporting is inconsistent, meaning that comparisons are not readily made across time periods or between the performance of different jurisdictions. In the absence of more frequent national reporting, it is difficult to consolidate and compare state and local governments' progress. The potential for national oversight of accessibility in the five years between formal reviews is therefore challenging.

Despite inconsistent data, available information shows it is unlikely that services and infrastructure in most jurisdictions will be fully compliant with legislated requirements within the mandated timeframe. Table 3 shows key transport infrastructure for which there are data that are unlikely to meet targets. Progress against the Standards is possibly even worse than the data suggest. Information is not available for numerous types of infrastructure in different jurisdictions. For example, the accessibility of bus stops is not reported consistently in New South Wales.

Table 3: Numerous jurisdictions are unlikely to meet legislated accessibility requirements

Jurisdiction	Mode	Percentage accessible	Year
New South Wales	Railway stations	53.7%	2018
Victoria	Bus stops	52%	2012
	Tram stops	22%	2018
	Trams	24%	2018
Western Australia	Railway stations	53%	2018
South Australia	Buses	80%	2018
Australian Capital Territory	Bus stops	55%	2012
Tasmania	Buses	52%	2017
	Bus stops	37.5%	2017

Note: This is not presented as a comprehensive view, as not all jurisdictions publicly publish their progress.

Source: Transport for NSW (2018), Department of Transport (2012), Victorian Auditor-General's Office (2018), Transperth (2019), Government of South Australia (2018), Transport Canberra (2019), Metro Tasmania (2018)²⁶⁶

A lack of funding is perhaps the greatest challenge in meeting legislated standards. The latest review of the Standards identified that the infrastructure upgrades required between 2017 and 2022 are likely to cost the most, and achieve the lowest relative benefit to accessibility, making them unattractive investments to governments.

The financial pressure has been highlighted by local governments, which are often responsible for bus stops. Local Government NSW notes that the introduction of the Standards was not accompanied by additional funding for implementation, making it difficult to meet requirements.

State government operators have also struggled financially. Metro Tasmania, the state's largest government-owned transport operator, has advised it is unlikely to meet 2022 accessibility targets as significant financial investment is required and this has not been provided for in future budgets.²⁶⁷

There are also practical limitations in meeting targets. In some circumstances, networks would require significant overhauls or redesigns in order to be fully accessible. The City of Newcastle, for example, has advised that about 30% of all bus stops will never be compliant because many of them are on a slope, which means their access gradient exceeds requirements.²⁶⁸

Significant progress has been made in making public transport accessible since the Standards were introduced in 2002. However, there is still plenty of work to be done. It is unlikely that operators, and state and local governments will meet all requirements by the legislated deadline. There are numerous causes, including a lack of funding for upgrades and the practicalities of undertaking very large infrastructure programs and projects within the required timeframe.

Point-to-point transport will have a bigger role to play

While the focus of Disability Standards is on public transport, not everyone is physically able to use even compliant services. Of the 4 million-plus Australians living with disability, 250,000 can only use some form of public transport and 590,000 are unable to use any public transport at all.²⁶⁹

State governments historically have provided assistance by subsidising taxi fares for people who are unable to use scheduled public transport, and imposed obligations and offered registration incentives for taxis to be wheelchair-accessible.

Emerging transport operators, such as UberASSIST, are beginning to introduce fully wheelchair-accessible services. However, disability advocates have expressed concern that such operators are not consistently subject to the same subsidy schemes or regulatory obligations as taxis, meaning there are still very few accessible ridesharing options.²⁷⁰

Emerging transport operators are expected to play a bigger role in service provision in the next five years. The challenge for governments will be to ensure that benefits of new mobility business models extend to people with disability.

70. Challenge

There is insufficient funding to make our public transport networks accessible to people with disability. Unless funding shortfalls are addressed, legislated accessibility targets for public transport will not be reached and our networks will not be inclusive.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



71. Challenge

Emerging point-to-point operators are not subject to the same subsidy schemes and accessibility legislation as taxis, meaning they are not accessible to many people with disability. Without action, people with disability will not share in the benefits of emerging transport modes.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:





Freight transport

5.9 Introduction



The state of the freight transport sector

Australia's freight transport task is diverse and growing. Global demand for our exports, particularly from Asia, has resulted in unprecedented growth. This is coupled with increasing demand for imports and a growing expectation that consumer items are delivered to our homes or offices. Our geography and varied climate also mean that Australia continues to produce a broad range of agricultural products, each with a unique supply chain.

The performance of our freight networks varies across the country. Australia is home to some world-leading mineral supply chains, particularly in the Pilbara, Central Queensland and Hunter Valley. However, our urban and agricultural supply chains in particular are experiencing challenges.

Our cities are key centres of demand, supply and the processing of high-value and containerised freight. However, too often they act as bottlenecks

on our national supply chains, limiting access to key markets for exporters and increasing costs for consumers. Congestion on key routes, and land-use planning that does not consider freight and regulatory constraints on our gateways, are common challenges.

Agricultural supply chains also suffer from constraints. Local infrastructure is often poorly maintained and lacks capacity. Infrastructure constraints are coupled with inefficient regulation in our regions, where freight operators often cross jurisdictional boundaries and have to deal with a myriad of access permits.

Australia is well positioned to take advantage of Asia's economic development. But to do so, we need to ensure our freight and supply chains operate efficiently and minimise costs for business and consumers.



Australia's freight task is diverse, and growing fast

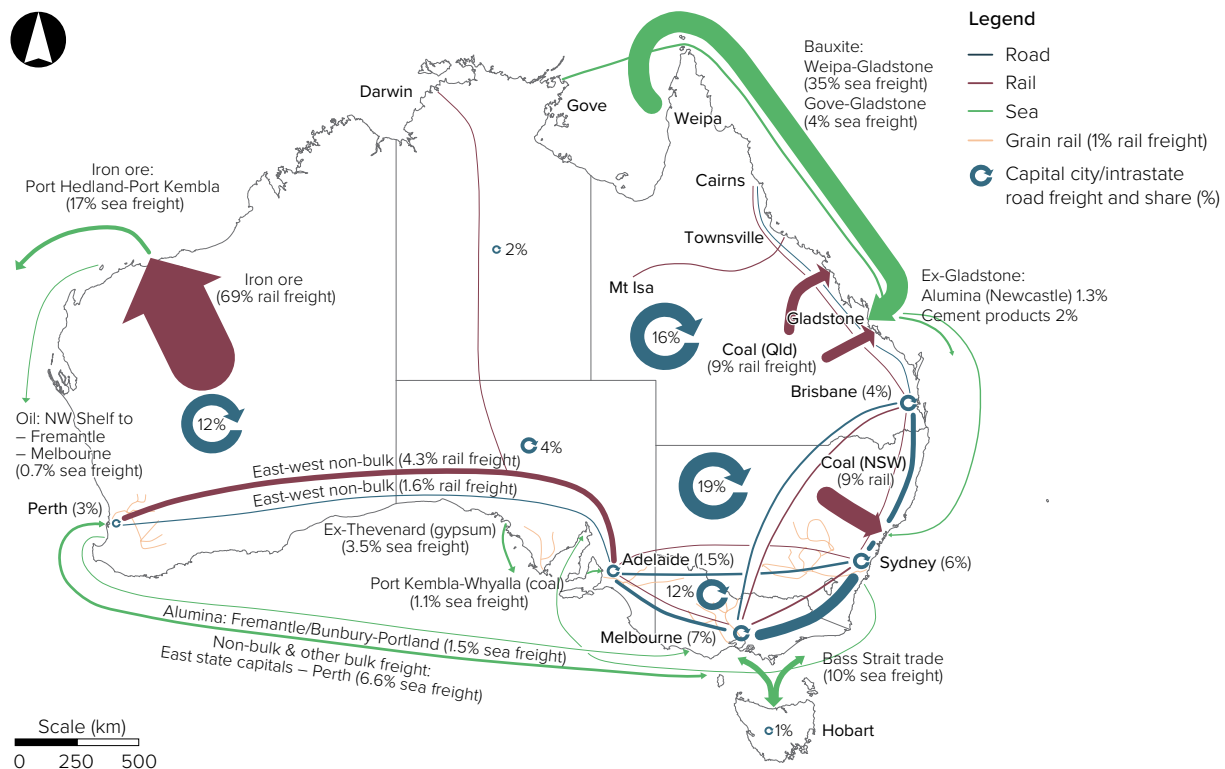
Australia's population is increasing rapidly, but the freight task is growing even faster. In the 10 years to 2016, the domestic freight task grew by 50% while our population grew by 18% over the same period.²⁷¹ In 2015-16, Australia's freight network moved about 726 billion tonne kilometres of freight. That is almost 30,000 tonne kilometres moved for every person in Australia in just one year.²⁷²

Australia's freight task is expected to continue growing at a faster rate than population growth, as our exports grow and consumers demand not only more goods, but increasingly expect goods to be delivered quickly and to their door. The freight task is forecast to grow by another 26% between 2016 and 2026.²⁷³

The freight task in Australia is diverse and the needs of individual supply chains can vary substantially. Freight transport therefore requires nuanced policy, regulation and strategic infrastructure investment to ensure different supply chains can operate effectively. Figure 27 provides a snapshot of freight flows, which broadly encompasses:

- The movement of bulk commodities, largely for export, such as iron ore, coal and liquefied natural gas (LNG)
- The transport of agricultural produce including grains, cotton, rice, sugar and livestock
- The import and transportation of manufactured goods, machinery and motor vehicles
- The transport of largely imported consumer items to retail outlets and, increasingly, direct to people's homes and offices
- Construction-related traffic
- Waste transport, disposal and recycling.

Figure 27: Major freight flows in Australia are diverse



Source: Bureau of Infrastructure, Transport and Regional Economics (2019)²⁷⁴

The performance of our freight networks is varied

This Audit assesses the performance of our freight networks through the lens of access, quality and cost. Australia is home to some world-leading supply chains. Our large iron ore and coal supply chains in the Pilbara (Western Australia), Central Queensland and the Hunter Valley (New South Wales) are some of the most efficient in the world. These supply chains allow for enormous quantities of minerals to be mined, transported and exported. Western Australia alone accounts for close to 40% of global iron ore production and 57% of seaborne exports,²⁷⁵ and the Port of Newcastle is the largest coal port in the world.²⁷⁶

However, our agricultural, non-bulk and urban supply chains face challenges. Access to supply chains and markets are hindered by inconsistent regulation between jurisdictions and levels of government. Due to the variable standards to which roads are constructed or maintained, road operators in particular face restrictions on the weight, height, width and axle configuration of vehicles they use on different roads. This means access to routes can be inconsistent, confusing and can increase their administrative burden.

The quality of our infrastructure can also impact on access for these supply chains. Grain railways and local roads generally have lower technical specifications than state-significant and interstate routes. This means, in bumper harvest years, they lack the capacity to carry goods to market. Our urban supply chains can also hinder access to markets when they become congested. In Sydney and Melbourne in particular, delays on access routes to key facilities such as ports, intermodal terminals and airports are common.

Costs are incurred at different points on the supply chain, as different businesses sell, process, store and transport a product before it is finally sold. Ultimately, freight costs account for a proportion of the final cost a consumer pays for a product. The costs of freight declined sharply in the second half of the 20th century due to increasingly efficient vehicles, containerisation and industry reform.²⁷⁷ Costs have remained largely stable since the 1990s,²⁷⁸ but could be lowered in the near future by technological developments such as automation and further mechanisation.



There has been progress since the 2015 Audit, but it is slow

Many of the challenges identified in Infrastructure Australia's 2015 Audit remain today. Freight demand continues to grow quickly, congestion remains on key urban freight routes, inconsistent regulation hinders efficiency and key regional bottlenecks still constrain agricultural supply chains.

There has been some progress on key reforms, but they remain incomplete. In 2011, Australian governments agreed to establish a national system of freight regulation, with the establishment of national regulators and the transition from state laws occurring progressively. Since the 2015 Audit, the transition to national rail safety regulation has been completed.

Progress has also been made with heavy vehicle regulation, with jurisdictions progressively transitioning to the National Heavy Vehicle Regulator (NHVR). However, progress has been slow, and heavy vehicle regulations remain inconsistent and difficult for industry to understand. The Western Australian Government has not agreed to participate in the NHVR, so operations in the state are covered by a separate system of rules and regulations.²⁷⁹

Technology has progressed and begun to improve the efficiency of key freight facilities since 2015. For example, the introduction of automatic straddles at numerous ports means that the transfer of containers from ships to trucks and trains, which in 2015 was largely carried out by dock workers, is now automated. The impact of technology is likely to

grow in the freight sector, with automation potentially reducing freight costs into the future.

Finally, safety has improved since the last Audit, as the number of fatal crashes and other causes of death involving heavy vehicles has declined. However, change remains slow and the road freight sector still has the highest fatality rate of any industry in Australia.²⁸⁰

Our freight networks are crucial to capitalising on Asia's growth

Asia's growth is leading the world economy and driving demand for Australian commodities. The OECD estimates that 66% of the world's middle class will be living in Asia by 2030, compared with 28% in 2009.²⁸¹

Australia is well placed to take advantage of this development. The vast majority of our exports, close to 70%, are already delivered to East Asia.²⁸² The majority of our imports also comes from Asia, as China in particular has become a global manufacturing hub.

However, our ability to capitalise on Asia's growth relies on an efficient and effective freight network. The vast size of the Australian continent presents a challenge to the competitiveness of Australian producers, who not only must export to distant markets but also negotiate the distance from paddock, pit or plant to port. Improvements in the way goods are moved domestically will reduce the costs of exports as well as benefiting local consumers.



Freight is a key component in costs for Australian exporters and the price paid by consumers for imported items. The Australian economy can receive a significant boost from growing international trade, but ensuring our supply chains are efficient is critical.

Our cities are bottlenecks for freight

Our cities are central to the freight network and international trade. Many of our most important freight facilities are located in our four largest cities, Sydney, Melbourne, Brisbane and Perth. About 96% of Australia's air freight passes through our four largest airports, and these cities are also home to our largest container ports.²⁸³

The location of these facilities is no accident. About 60% of Australia's population lives in our four largest cities. This means they are our major market for domestic and imported goods. For example, about 87% of containers imported into the Port of Melbourne have a final destination that is within metropolitan Melbourne.²⁸⁴ Our urban ports and airports are also critical to regional supply chains. About 90% of New South Wales container exports move through Port Botany in Sydney.²⁸⁵

However, our cities are too frequently bottlenecks in our supply chains. Freight often shares road and rail infrastructure with passengers, and congestion on key access routes are common. Land-use planning is also poorly coordinated with freight operations, leading to operating restrictions on key facilities. For example, Sydney Airport is our largest air freight handler but is subject to a curfew between 11pm and 6am. In addition, intermodal terminals and warehouses can be limited in their operating hours by local governments due to concerns about noise impacts on residential areas.

There is also a growing micro-freight challenge in our cities. As people increasingly shop online, they expect goods to be delivered to their home or office within a short timeframe. This can exacerbate congestion on our roads and in loading zones. In Sydney, light commercial vehicles, or delivery vans, make up about 15% of traffic, which is about 6% more than heavy freight vehicles.²⁸⁶

As our freight task grows and we become more urbanised, it is increasingly critical that we recognise and address the key challenges facing our urban freight transport networks.

Agricultural supply chains face infrastructure and regulatory constraints

The quality and efficiency of our regional supply chains vary enormously. Our large mining supply chains are world-leading, while our agricultural supply chains often struggle with bottlenecks, and low-quality or poorly maintained infrastructure.

The scale, diversity and seasonal nature of Australia's agricultural activity make these supply chains complicated from a governance and infrastructure provision perspective. Infrastructure is expensive to build and maintain, and governments and infrastructure managers are incentivised to invest when infrastructure is consistently and heavily used.

However, the geographic spread and seasonal nature of a lot of agricultural activity means that expensive infrastructure can be underutilised for months and sometimes years before receiving significant traffic. This means local roads and branch railways in particular are of a lower structural standard than main freight routes which have more consistent traffic flows. The result is that bumper crop years can overwhelm local infrastructure, meaning farmers and business are unable to get their product to market within an optimal timeframe.

In this chapter

5.10 Freight gateways supporting international trade explores Australia's ability to capitalise on world growth, especially Asia's, through efficient domestic and international freight networks. Specifically, we look at the performance of and challenges faced by our main container ports and international airports.

5.11 The urban freight challenge analyses the problems that our freight networks face in our major cities. We look at poorly coordinated land use and transport planning, the impact of congestion and the unique challenges posed by the growth of micro-freight.

5.12 Ensuring the national freight network is effective and efficient investigates the impact of inefficient regulatory structures, the potential benefits of technology for the freight sector and the importance of safety for road freight.

5.13 Unlocking regional economic development through freight explores the diversity of regional supply chains and some of the challenges of providing sufficient infrastructure for seasonal agricultural flows. We also look at the potential for freight investments to act as catalysts for regional development.

5.14 Transporting, storing and making the most of our waste explores the challenges faced by Australia's waste sector. Specifically, we look at the growing pressure on the sector due to population growth, export bans and heightened environmental awareness.

Performance of the sector

Access



Australian exporters
spend five times more
than Canadian exporters on border compliance costs ²⁸⁷



Quality

Delivery times could

reduce by 40%

with autonomous vehicles ²⁸⁸

44%

of domestic air freight is carried on dedicated freight planes ²⁸⁹

Access



Cost



Autonomous vehicles could reduce trucking costs by 47% ²⁹⁰

Quality



50% of people rate postal services as good ²⁹¹

Cost



37% of people rate postal services as costly ²⁹²

30,000
tonne kilometres

moved for every person each year ²⁹³

Access

Quality

1 in 5 people

do not have an opinion on the quality of their freight services ²⁹⁴



Cost

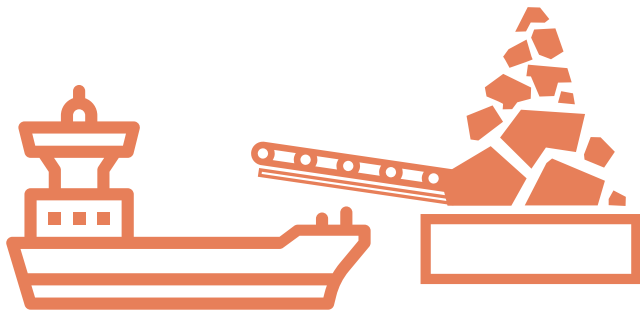


Freight is **5%**

of the retail cost of doing business ²⁹⁵

Scale of the sector

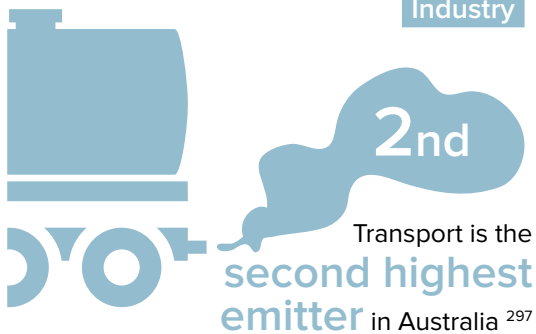
Asset



Port Hedland, the world's largest bulk export port, handled

519,000,000
tonnes in 2017–18²⁹⁶

Industry



Customer



Every year,

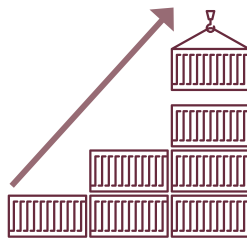
three
truckloads
of freight

is moved per person²⁹⁸

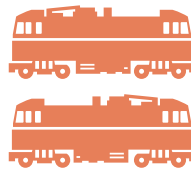
Customer

From 2016 to 2026, freight will grow by

26%²⁹⁹



Asset



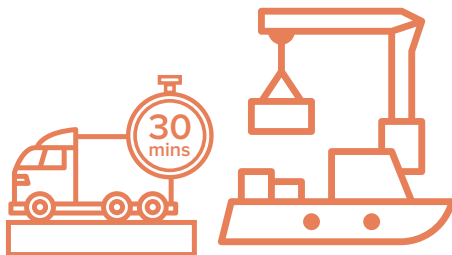
There are almost

2,000

operational locomotives in Australia³⁰⁰

Asset

On average, trucks wait **30 minutes** to pick up cargo at major ports³⁰¹

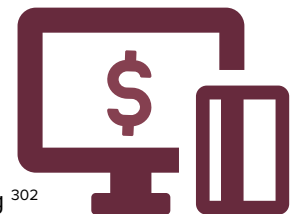


Customer

Each year, Australians spend about

\$1,000

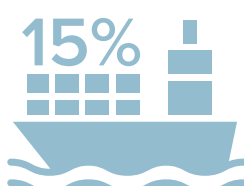
each on online shopping³⁰²



Industry



About **1/3** freight tonne kilometres carried by trucks



About **1/6** of freight tonne kilometres is carried via coastal shipping



1/2 of freight tonne kilometres is carried on rail³⁰³

5.10 Freight gateways supporting international trade

At a glance

Efficient domestic and international freight networks are critical to helping us capitalise on world growth, especially in Asia. This section looks at the key freight infrastructure directly supporting these networks:

- Ports are our main international trade gateways, supporting our largest industries. But the shipping and logistics industries are changing fast, and our ports must adapt to keep up.
- Airports move a small but high value portion of freight, including sensitive or perishable goods. Freight will soon outstrip passenger growth, so the sector must balance that conflict of interest.

Our large cities contain some of our most important gateways to sea and air trade routes. These gateways are vulnerable to congestion and are reliant on direct investment in freight-specific assets.

Asia's growth presents freight and trade opportunities for Australia

Australia is heavily reliant on trade. Our exports make up about 21% of GDP,³⁰⁴ and the vast majority of our commodities are exported, with 77% of agricultural produce, 75% of coal and 98% of iron ore going to international markets.³⁰⁵

The rapid development of Asia's middle class, and associated changes in consumption patterns, present both challenges and opportunities for Australia's freight sector. In 2017, about 66% of Australia's exports were for East Asia, with China's share of those exports having doubled in the last 10 years to account for 30% of total exports.³⁰⁶

Asia's growth has resulted in increased steel production and energy demand. As a result, demand for Australian iron ore, coal (metallurgical and thermal) and more recently LNG has accounted for most of Australia's export growth since 2006-07 (Figure 28).³⁰⁷

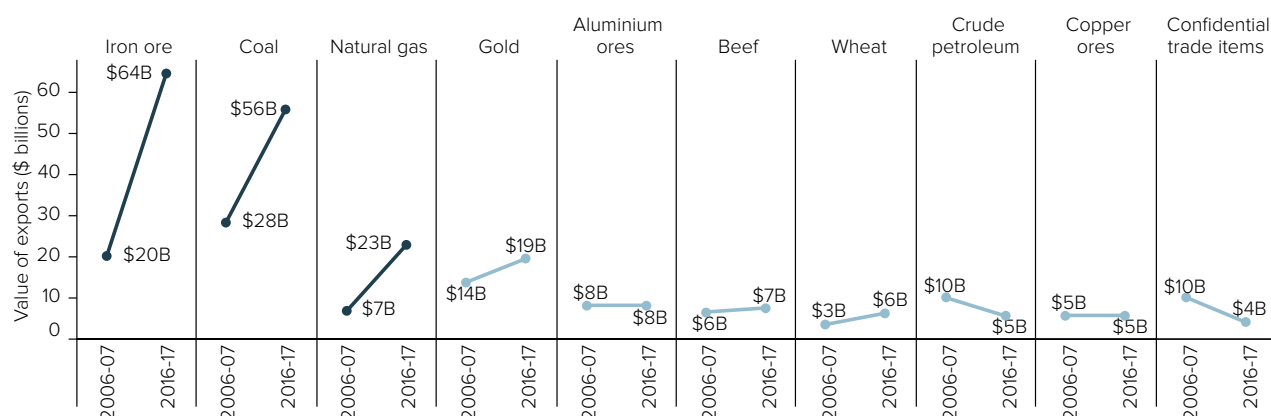
Australia's freight network is also critical for ensuring imports are delivered to Australian consumers at the lowest possible price and in a timely fashion. Australia is part of an increasingly globalised economy, meaning that many of our daily needs, including food, consumer goods and manufactured items, are imported. Some of Australia's largest imports, by value, are motor vehicles, refined petroleum, computers and medication.³⁰⁸

Australia's network of freight infrastructure assets has handled rapid growth in domestic and international demand. There has been significant expansion of our freight networks in recent years, with the largest capital projects being the expansion of private rail and port infrastructure for the export of iron ore and coal. Stevedores, logistics companies and port operators have also continued to invest in new capacity in containerised transport to ensure consumer goods reach their markets efficiently.

Capital investment has been accompanied by reform. There has been a widespread push by state governments to privatise capital city ports, providing these assets with a stronger commercial focus and generating capital to fund new and improved infrastructure. Since the 2015 *Australian Infrastructure Audit*, the ports of Darwin and Melbourne have been transferred to the private sector under long-term leases.

However, despite the progress, there remain significant challenges for our freight sector. These range from regulatory competition and pricing concerns, to infrastructure capacity constraints, particularly in regional areas and around our ports. Collectively, these challenges reduce access to our networks and increase costs across our supply chains, ultimately reducing our competitiveness.

The key will be to ensure freight infrastructure markets are operating as efficiently as possible, and our infrastructure networks are fit for purpose, to ensure Australia can take advantage of Asia's growth.

Figure 28: The value of iron ore, coal and natural gas exports has grown substantially in the last decade

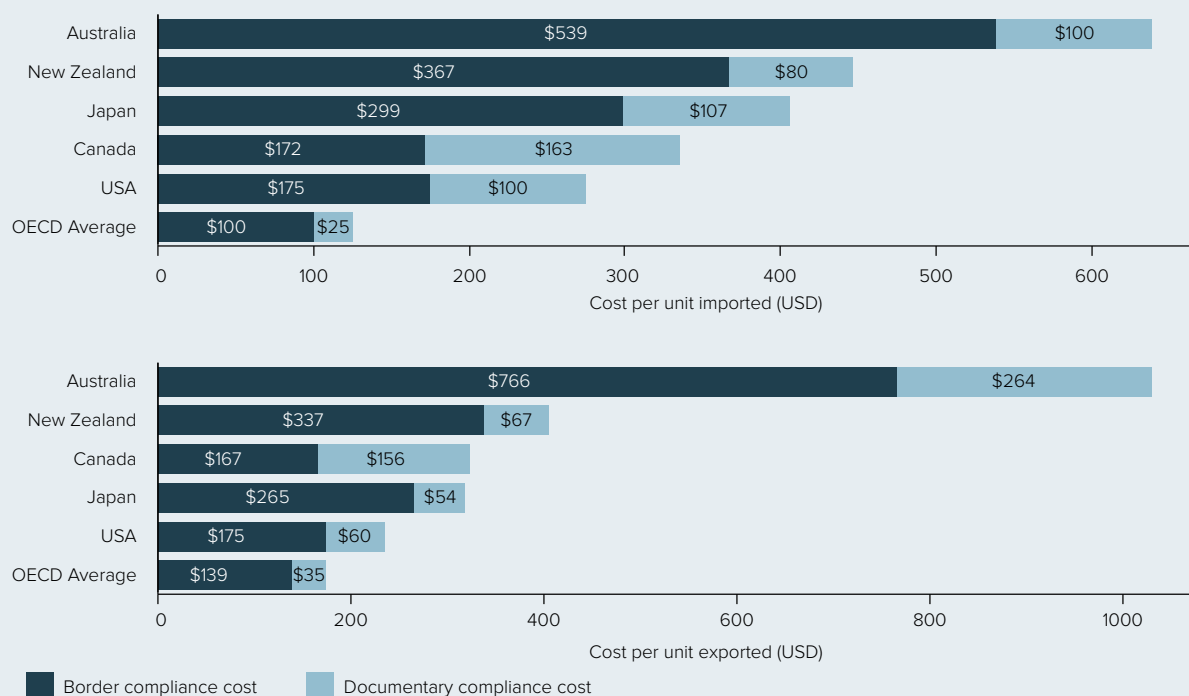
Note: Values are inflation adjusted to September 2018.

Source: Department of Foreign Affairs and Trade (2018)³⁰⁹

Australia's costs for exporting and importing are high

The World Bank has found that Australia's international trade costs are higher than for many other high-income OECD countries.³¹⁰ The report measures the cost for documentary compliance (obtaining, preparing and submitting documents) and border compliance (including customs and inspections).

Australia performs worse than the OECD average against virtually every metric, with the cost for exporters particularly high. While the OECD average is dragged down by European Union countries, Australia still struggles to compete with countries outside Europe (Figure 29).

Figure 29: Costs for Australian exporters and importers are higher than in comparable countries

Note: All values are for 2018. The World Bank's methodology applies an extensive range of assumptions to allow for comparability across economies.³¹¹ Import and export costs assume different traded products. Import costs are based on a standardised shipment of 15 metric tonnes of containerised auto parts from each country's largest provider of auto parts. Export costs are based on a shipment of each country's product of its comparative advantage to the economy that is the largest purchaser of this product.

Source: The World Bank (2019)³¹²



72. Opportunity

Growth in Asia and an increasingly globalised economy means the volume and value of Australia's trade is increasing. Enhancing, adapting and realigning freight networks will allow Australian producers to capitalise on opportunities presented by growing global markets, and Australian consumers to access imported goods as cheaply as possible.

When this will impact:



Where this will impact:



Our ports are becoming more efficient, but there is room for improvement

Ports are our principal gateways to international trade. Ports and related land-side supply chains are critical to the competitiveness of Australian businesses, which rely on these gateways to import raw materials and manufactured goods, and to take our mineral and agricultural products to the global market. They support some of our largest industries, such as mineral extraction, agriculture and manufacturing.

Australian port activity can be split into two primary functions:

- Specialised bulk export ports, with the largest focusing on iron ore and coal, and located largely at regional centres
- Mixed (import and export) ports, handling containerised, bulk and so-called roll-on/roll-off cargo, located in our capital cities and some regional centres.

Our specialised bulk ports are some of the largest in the world and their supporting supply chains are considered world leading. For example, Australia has the largest iron ore and coal export ports in the world in Port Hedland and Newcastle, respectively, with equivalently scaled rail infrastructure networks.³¹³

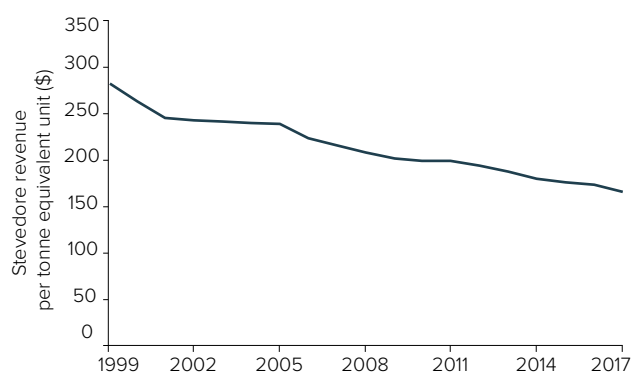
The value of exports through Australia's ports in 2015-16 was almost \$220 billion while imports stood at \$202 billion.³¹⁴ Fluctuations in market conditions over the last decade, particularly in coal and iron ore prices, have meant that import and export volumes at bulk ports have varied. Nevertheless, Australia's bulk export ports are broadly well positioned to accommodate future demand shifts, either at the wharf edge or in the supply chain. They are anticipated, therefore, to require little direct support from government.

Our mixed freight container ports, however, are faced with both challenges and opportunities due to rapidly evolving international shipping and logistics industries. These industries are in a state of transition, with changes impacting the operation and pricing practices of ports in Australia. These changes include:

- The shipping industry has undergone consolidation and larger shipping lines have been able to use their market strength and bargaining power to improve port rates, including docking and freight handling fees.³¹⁵
- Three stevedores now operate at each of Australia's east coast capital city ports. When combined with a general increase in costs (particularly property), this has driven growth in competition between these stevedores.
- There has been significant investment and expansion of our major container ports, helping to accommodate growth and increase port productivity.
- There is a trend towards larger ships. This is impacting on quayside infrastructure, requiring port managers to augment waterside facilities through projects such as deepening and widening channels, expanding turning areas and removing height restrictions.³¹⁶
- The impact of technology on port and freight handling activities has increased and is being used to improve productivity and reliability, reduce costs and improve convenience for freight customers.

The result of these trends can be positive for consumers. Costs paid between different segments of the supply chain contribute to the final price paid by the customer. Prices paid by shipping lines to stevedores at Australia's major capital city ports have declined over the past 20 years (Figure 30). Decreases in the last five years in particular can be attributed to growing competition between stevedores at our ports and the improved bargaining position of shipping lines as they have become larger.³¹⁷

Figure 30: Stevedore revenue per Tonne Equivalent Unit has been declining at Australian capital city ports



Source: Australian Competition and Consumer Commission (2018)³¹⁸

However, the decrease in costs paid by shipping lines has coincided with significant increases in charges paid by land transport operators (truck and train companies) for collecting or delivering laden containers to and from the port (Table 4). In other words, costs may have shifted from shipping lines to land transport operators, where they have more market power.

However, the Australian Competition and Consumer Commission has raised concerns that, if left unconstrained, stevedores may have the ability to continue to increase charges imposed on land transport operators beyond what is necessary to recover costs and make an adequate return. The Commission's concern is that land transport operators are unable to choose between stevedores because they simply pick up or drop off the cargo owners' consignments. In other words, land transport operators do not benefit from competition between stevedores in the same way shipping lines do.

High costs met by land transport operators are passed on to cargo owners, who also face practical constraints to choosing different stevedores. The nature of the supply chain means costs are ultimately passed on to Australian consumers (or exporters and cargo owners), so that the benefits of increased competition between stevedores may not be realised equally across the supply chain. The challenge for government will be to know if and when a regulatory response is required.³¹⁹

Table 4: Stevedores have increased charges per container for train and truck operators

Port	DP World			Patrick		Hutchinson	
	2016-17	2017-18	2018-19	2016-17	2017-18	2016-17	2017-18
Brisbane	\$32.74	\$38.75 +18.4%	\$65.15 +68.1%	\$32.55	\$38.25 +17.5%	\$32.00	\$32.60 +1.9%
Fremantle	\$8.22	\$8.22	\$8.22	\$4.76	\$7.50 +57.6%		
Melbourne	\$32.50	\$49.20 +51.4%	\$85.30 +73.4%	\$32.00	\$47.50 +48.4%		
Sydney	\$21.16	\$37.65 +77.9%	\$63.80 +69.5%	\$25.45	\$41.10 +61.5%	–	\$10.45

Note: The table excludes the Victorian international container terminal, as charges remained constant between 2016-17 and 2017-18.

Source: Australian Competition and Consumer Commission (2018)³²⁰

73. Challenge

Charges for truck and train operators accessing our major ports have increased and could be passed on to customers. It is challenging for governments to know if and when a regulatory response is required. Stevedores may have the ability to continue increasing charges, which may lead to growing costs for Australian exporters and consumers.

When this
will impact:

0-5

5-10

10-15

15+

Where this
will impact:

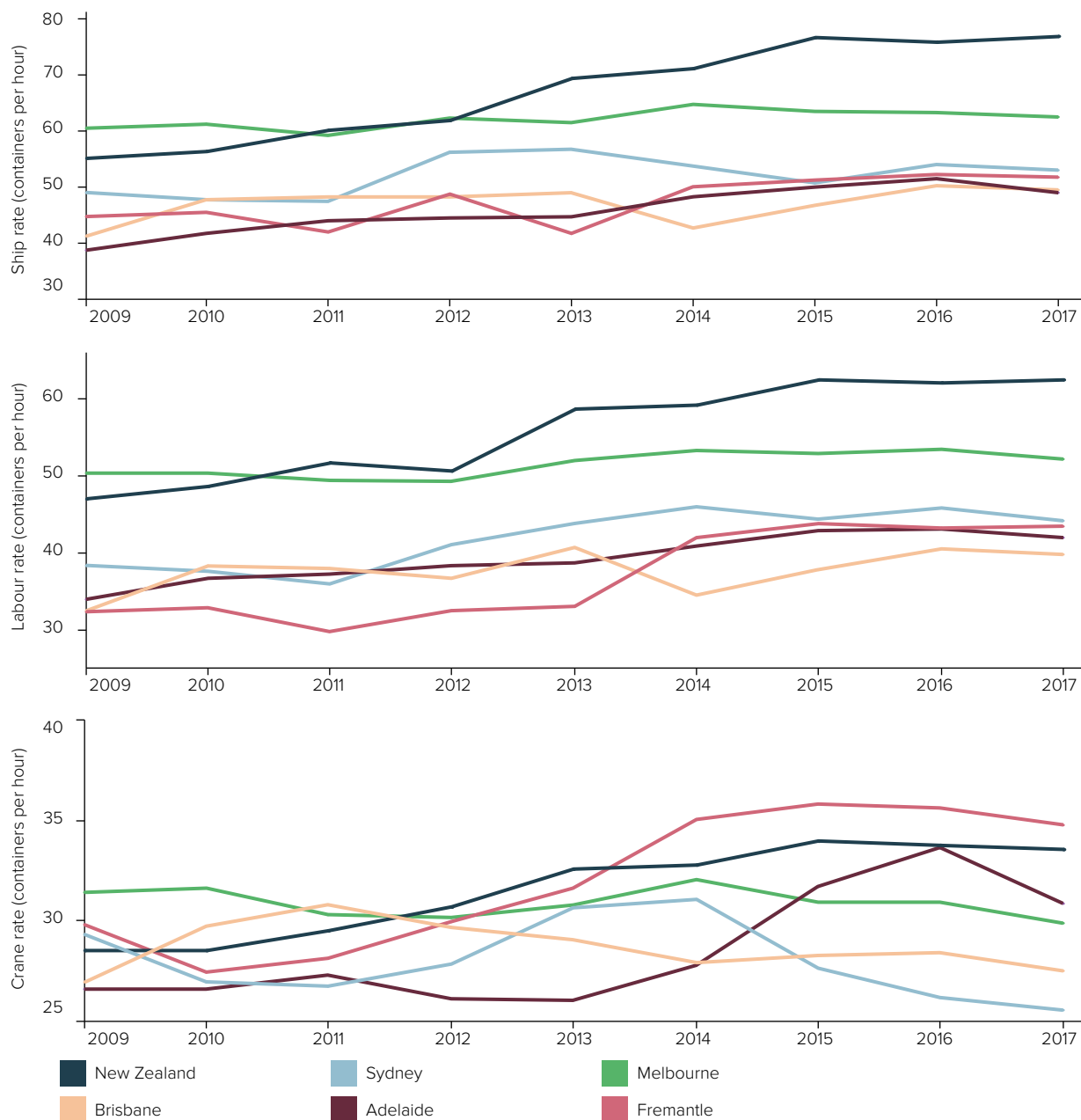


Our ports also face productivity challenges. Recent changes in shipping and technology, as well as investments in infrastructure at our ports, have likely contributed to gradual improvements in port productivity in recent years. However, our ports continue to lag behind other industrialised countries.³²¹

Based on the most recent available and relevant inter-country comparison, Figure 31 shows three common port efficiency indicators – labour rate, ship rate and crane rate – at major Australian ports compared to ports in New Zealand. Australian ports remain behind those in New Zealand, for all indicators.

Efficiency is significantly higher than benchmarks established in 1998-99 (although consistent time series data are not available) and remains close to record levels. However, progress in recent years has been more gradual, and in the case of crane productivity has declined slightly. The challenge for port operators, stevedores and governments will be to ensure that Australian ports continue to make efficiency improvements in the face of an evolving international industry and rapidly changing technology.

Figure 31: Australian ports are less efficient than New Zealand's in most productivity metrics



Note: Ship rate records the average number of containers transferred to and from ships by cranes and labour. Labour rate measures the number of containers handled for the period of time between labour first boarding a ship to leaving the ship. Crane rate reflects the number of containers handled per crane hour while cranes are in operation.

Source: Bureau of Infrastructure, Transport and Regional Economics (2019)³²²



74. Challenge

Our major container ports are becoming more productive, but continue to lag behind our trading partners for key indicators. Our ports will need to continue to improve to ensure Australia is globally competitive. Without improvement, our ports will continue to be uncompetitive, potentially increasing the time taken to import and export goods and add to costs for Australian exporters and consumers.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Airports are critical for the movement of high-value freight

Air freight represents a small proportion of Australia's freight task by mass, a mere 1.5 million tonnes or 0.1% of freight moved in 2016-17. This, however, obscures the critical importance of air freight to Australia:

- It represents over 21% of trade by value.³²³
- 70% of air freight has an international origin or destination and therefore contributes significantly to Australia's international trade and its trade relations.³²⁴
- Goods most suited to air freight are those that are time-sensitive, compact, perishable or high value.

Significant increases in freight trade are forecast for Australian airports over the next 20 years. Melbourne Airport forecasts its international air freight will grow by 57% between 2013 and 2033,³²⁵ and total freight at Sydney Airport is forecast to grow by 58% to one million tonnes between 2017 and 2039.³²⁶ Indeed, growth in Sydney's air freight is predicted to outstrip passenger growth over the same period.

Despite the potential for growth, however, the air freight sector is faced with major challenges.

The first of these relates to managing competing land uses. Two airports, Melbourne and Sydney, carry by far the greatest share of air freight (Table 5). Both airports have experienced ongoing development in surrounding areas.

In Sydney, the city most significantly affected in this way, non-aviation development around the Kingsford Smith Airport has been a challenging consequence of its position less than 8 km from the Sydney CBD. This location is well within the ring of inner suburbs which, as in all large Australian cities, has become a highly attractive location for governments and developers seeking to increase residential density.

While this location may deliver the airport significant benefits in terms of passenger access, it comes at the cost of increasing constraints on other airport users. Here, as in Melbourne, non-aviation-related development has resulted in increased road congestion at airport access points, impacting the efficiency of air freight distribution.³²⁷ As an illustration, 52% of the traffic movements during the morning and evening peaks on Airport Drive, the primary feeder road around Sydney Airport, is non-airport through-traffic.³²⁸

Table 5: Sydney and Melbourne account for the majority of Australia's air freight

Airport	Exports (tonnes)	Imports (tonnes)	Total (tonnes)	Share
Sydney	255,173	205,065	460,238	47.3%
Melbourne	166,233	114,346	280,579	28.8%
Brisbane	67,740	40,818	108,558	11.2%
Perth	54,302	30,317	84,619	8.7%
Adelaide	14,621	7,941	22,562	2.3%
Cairns	4,677	516	5,193	0.5%
Darwin	900	897	1,797	0.2%
Other	4,578	5,363	9,941	1.0%
Total	568,225	405,265	973,490	

Note: Values represent tonnes imported or exported in 2016.

Source: Inquiry into National Freight and Supply Chain Priorities (2018)³²⁹

The development of the new Western Sydney Airport provides a unique opportunity for integrated and long-term land-use and freight infrastructure planning. Given Sydney is so critical to Australian air freight, improvements in that city could help improve the efficiency of the network across the country.

The second challenge relates to the fact that most air freight is carried in the hold of passenger flights (with only 17% of international and 44% of domestic cargo movements being made on dedicated air freighters).³³⁰ As a result, freight and passenger activities overlap.

Rapid growth in passenger numbers in recent years at major airports has led to the expansion of passenger-oriented facilities and placed pressure on freight facilities that are located near runways and terminals, such as hangars, freight aprons and cargo bays.³³¹ Moving freight facilities to less accessible parts of an airfield or off-airport can increase delays and handling costs. This is particularly an issue for the movement of air freight in Sydney, which has constraints on its land footprint, and is located in close proximity to Port Botany and has shared road networks. Businesses involved in air freight operations have noted they would like to see airports better balance the needs of freight services with passenger demands.³³²

The third issue relates to regulatory controls and operational limitations on flight arrivals and departures. Curfews are in place between 11pm and 6am at Adelaide, Sydney, Gold Coast and Essendon airports. These were introduced in 1995, primarily to limit noise impacts on surrounding residential areas. Additionally, Sydney Airport is subject to a cap on hourly movements during the hours when it is operating.

Recognising that Sydney carries approximately half of Australia's air freight, these restrictions significantly reduce the volume of landed air freight. Relaxation of operational restrictions could add significant capacity. The Sydney Business Chamber has pointed out, for instance, that relaxing the cap by five flights per hour would increase capacity by 16,425 flights per annum.³³³

Agricultural producers are among the exporters potentially benefiting from reduced restrictions on operating hours at our airports. Supplying the growing Asian middle class with high-standard Australian produce could be facilitated by opening up overnight air freight pathways for perishable goods to reach time-sensitive markets. The planned curfew-free operation of Western Sydney Airport will help New South Wales producers to access such opportunities.

Regulatory controls on cargo can also add significant costs and delays. Air freight is subject to a range of customs and security procedures for both international and domestic freight. From March 2019, requirements for air cargo security measures increased substantially. All Australian cargo travelling overseas now needs to be examined at piece level (box, carton or similar item) or to originate from a

pre-approved list of exporters called the 'known consigner' list. The requirement was initially in place from July 2017 on all freight bound for the United States, but it is being expanded to cover all exports. The trend towards tighter security on air freight has the potential to negatively impact the productivity of our airports unless carefully managed.³³⁴

Western Sydney Airport – an opportunity to improve air freight efficiency and planning

The demand for flights in the Sydney region is forecast to double over the next 20 years and Sydney Airport cannot accommodate this demand alone. The Australian Government has committed up to \$5.3 billion in equity over 10 years to develop Western Sydney Airport (WSA), to open by 2026. WSA will be a full-service airport capable of catering for domestic and international services, including freight, with 24/7 operations.

Land use and ground transport planning for the area surrounding the new airport has aimed to minimise conflicts, to optimise integration with compatible activities in the innovative technology and export-oriented 'Aerotropolis' precinct, and to deliver land-side connectivity. Protection of the land around the airport has ensured that the distance from the south-western end of the WSA

runway to the closest suburban area will be over 10 km. This will allow WSA to operate without a curfew.

The Australian and New South Wales Governments are constructing new and upgraded roads around the future airport under the \$3.6 billion Western Sydney Infrastructure Plan. The governments have also committed to a long-term rail network to support Western Sydney, including a North-South Rail Link from Schofields to Macarthur. To ensure compatible land uses continue to develop across the region, WSA planning is deliberately aligned with the New South Wales Government's Western Sydney Employment Area, the Western Sydney Airport Growth Area (including the Aerotropolis) and the primarily residential South West Growth Area.

75. Challenge

The need to balance passenger and freight services, operating restrictions and constraints on airport land and surrounding roads reduces the efficiency of our airports. The efficiency of our airports could decline further as demand grows, potentially leading to delays and higher costs for high value, time sensitive air freight and passengers.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



5.11 The urban freight challenge

At a glance

As cities grow and demand for living space increases, governments must find ways to successfully integrate freight needs into their urban planning.

This section looks at how congestion, shared infrastructure and operating restrictions impact our urban freight networks. Cities typically prioritise passenger movement and local amenity over freight-related activities, but governments are increasingly looking for ways to balance these needs.

Micro-freight poses another challenge. This section explores how online shopping changes how our networks operate.

Land-use planning is critical for freight

Australia's largest cities are growing rapidly, and demand for land in the inner suburbs in particular has increased substantially.³³⁵ Increasing developer demand and land values place pressure on governments to zone land according to its highest possible return, which is generally residential and retail.³³⁶ This often means there is a shortage of strategically located and suitable land for industrial, freight and logistics purposes in cities.³³⁷

Conflicting demand for land in our cities is inevitable. Many of our most significant ports and freight facilities, such as Port Botany and the Port of Melbourne, are located near the historical centre of our cities, close to employment and retail nodes as well as residential areas. The challenge for governments is to get the balance right in planning for different land uses.

Land for consignment processing, for warehousing, for intermodal terminals and for container parks needs to be located near, or have high-quality transport links to, ports, airports and local manufacturers.

This is particularly important given the increasing role of e-commerce. Online shopping is changing the way purchasers and consumers interact with sellers. However, to ship goods efficiently and effectively means all parties need to be connected by clearly defined, protected and accessible road and rail networks.

Historically, integrated land-use and transport planning has been done poorly in Australian cities,³³⁸ and is likely the most significant factor in freight delays and congestion in our fast-growing cities. It can lead to:

- Unnecessary, long and expensive trips for trucks and light commercial vehicles, resulting in extra costs which are then passed on to consumers.
- Unnecessary handling of freight if key facilities are in separate locations.

- Inefficient use of infrastructure resulting from a lack of access to designated freight routes, leading to the use of 'rat runs' on roads that are not appropriate for freight traffic.
- Restrictions being imposed on operations to ensure surrounding residents are not disturbed, such as curfews and other time restrictions.
- Limited available space for industrial purposes, leading to inefficient container park and intermodal terminal layouts.

Despite the importance of more effective land-use planning for freight, governments have historically struggled to implement effective reforms to address these challenges. Lack of freight knowledge and conflict between proactive strategic planning and the regulatory role played by most planning agencies is likely to contribute to this. While freight planning issues are recognised in most strategic freight plans, actions to address them are often generic in nature, and do not sufficiently target specific and complex issues.

Infrastructure Australia's 2017 paper *Corridor protection: Planning and investing for the long term*, advocated the early identification and acquisition of transport corridors and industrial land. Not only does corridor protection save government funds, it is also critical in ensuring the positioning of industrial land is well planned and balances different functions.

While action to protect areas of land for different uses, and connecting corridors, will help improve future outcomes, the efficiency of existing facilities can also be enhanced by freight-oriented planning. Urban encroachment on existing facilities has the potential to result in operating restrictions and can also mean operators spend time and resources challenging development applications.

Urban encroachment at the Port of Melbourne

The Port of Melbourne has been operating for more than 140 years and is a nationally significant facility. However, the port's operators spend a great deal of time and resources challenging development applications for incompatible land uses on its borders. For example:

- Residential dwellings on the border of Webb Dock, with frontages to Todd Road and Williamstown Road (both are designated trucking routes), have been approved.
- A residential tower immediately west of Bolte Bridge has been proposed. The frontage of the building is on Lorimer Street, another designated trucking route. It is also near a port cement facility and existing reservation for the Webb Dock Rail Link.

- A café has been approved near the Coode Island petrochemical precinct. Initially a restaurant was approved for the site, but it was changed to a smaller café following a challenge from the Port of Melbourne to the Victorian Civil and Administrative Tribunal.³³⁹

Conflicts over land uses are inevitable, especially in high-density areas like central Melbourne. In addition, there will always be a need for negotiation and engagement by the Port of Melbourne with the community about surrounding land uses.

However, freight operators also raise legitimate concerns about regulations and restrictions being imposed on their operations due to nearby and newly approved incompatible land uses. It is an area where government has a clear role to play in balancing the needs of different parties.

76. Challenge

Conflict between land uses, particularly in the inner areas of our fast-growing cities, decreases the efficiency of our urban supply chains, particularly warehousing. Conflicting demand for land is inevitable, and governments face a challenge in balancing the needs of different parties. Failure to address land use conflict will result in more operating restrictions on key facilities, inefficient layout of facilities, and additional freight trips on out transport networks.

When this will impact:



Where this will impact:



The impact of congestion, shared infrastructure and curfews

Growing congestion on our roads and railways, particularly in our major cities, impacts the timeliness and costs of moving freight. This problem is only set to worsen with the forecast doubling of Australia's freight task over the next 20 years.³⁴⁰ Most congestion of our urban transport networks occurs on infrastructure that is shared between passenger and freight transport, with passenger cars and trains taking up the vast majority of network capacity.

About 80%-90% of freight transported in our cities is carried by road.³⁴¹ This means freight needs to share road space with cars and buses. The roads around container ports are increasingly congested. Many major cities have historically developed around their port, spreading along the coast or inland from that point of early European settlement. This means capital city ports are often based near parts of the

city that have high employment and population densities and, therefore, busy roads.

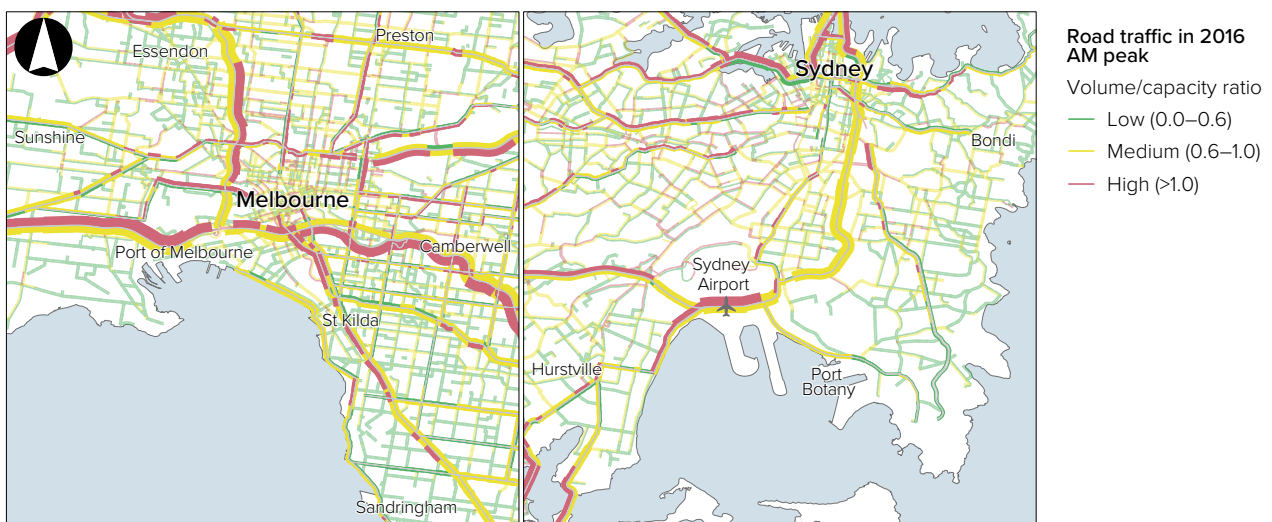
Our two largest container ports, Sydney and Melbourne, are near areas with very large volumes of passenger traffic (Sydney Airport and Melbourne CBD, respectively). Over 80% of freight passing through both ports is transported to or from warehouses and terminals within their respective capital city, meaning urban congestion has a significant impact on the cost of moving freight. Figure 32 shows congestion in 2016 around Port Botany and the Port of Melbourne. The mapping shows very heavy congestion on key arterial access routes to the ports.

Road congestion also has an impact on the movement of freight to and from our airports. Air freight is usually high value and often time sensitive, and commonly includes fresh foods as well as consumer items ordered online. This freight is often flown between Australia and overseas markets because customers place a premium on reliable and timely delivery.

The problem is particularly pronounced at Sydney Airport. It is Australia's largest air freight terminal, accounting for 24% of domestic and 47% of international air freight tonnes.³⁴² Figure 32 shows the volume of vehicles on roads surrounding the airport. Southern Cross Drive and Airport Drive, in particular, are operating well in excess of design capacity.

Shared railway infrastructure can also be a challenge for the movement of freight as passenger services are generally given priority on metropolitan networks. This means freight trains can access few train paths on the network, especially during peak passenger periods. Most jurisdictions have policies to increase the amount of freight carried on rail in their cities, to reduce growth in the number of trucks on roads. However, rail mode share remains stubbornly low and in some cases has even worsened over the past 20 years, averaging about 10% of total twenty-foot equivalent units carried to and from our capital city ports (Figure 33).

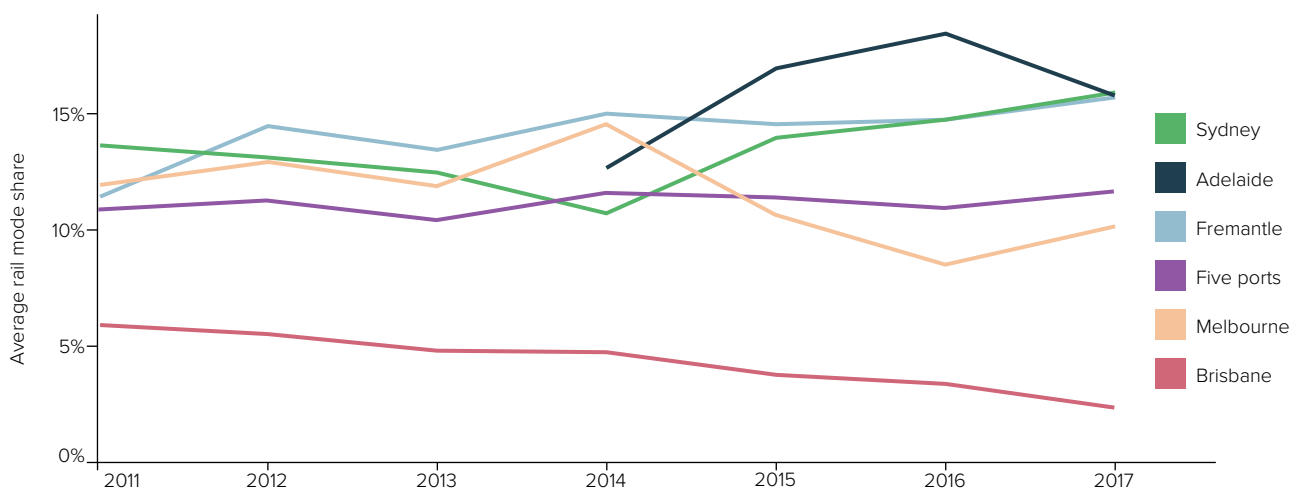
Figure 32: There is heavy congestion on key access roads to the Port of Melbourne and Port Botany



Note: Volume / capacity ratios show the quantity of traffic relative to a road's capacity. Any link operating at a VCR above 1.0 is coloured red, indicating that more vehicles are using the road than it was designed to accommodate under free flow conditions.

Source: Veitch Lister Consulting (2018)³⁴³

Figure 33: Rail mode share at Australian ports has remained low



Source: Bureau of Infrastructure, Transport and Regional Economics (2019)³⁴⁴

There are numerous reasons for this low mode share, with one major contributing factor being a lack of dedicated freight rail infrastructure. In Sydney, in particular, this means freight trains share tracks with passenger trains, with the latter being given priority, particularly in peak periods. Other reasons include rail pricing structures that incentivise long-distance over shorter-distance freight, and the inefficient layout or operation of rail yard infrastructure at ports and terminals.³⁴⁵

In addition, our urban freight networks often have curfews and operating restrictions imposed on them, limiting their capacity, flexibility and reliability. These time restrictions can be imposed for numerous reasons, including the impact of noise on surrounding suburbs and the decision to prioritise passengers during peak periods. While curfews impact the entire freight network, they are usually focused on specific modes or facilities, including:

- In Sydney, only 74 freight take-offs and landings are allowed each week during the curfew period, with only specific older aircraft allowed to operate despite the fact that larger and more modern aircraft emit less noise. In Adelaide, only aircraft generating noise at 95 decibels or less when landing are permitted.³⁴⁶
- While Sydney has a dedicated rail freight network, many freight trains also need to travel on shared passenger and freight tracks. Freight trains are not permitted to enter parts of the network during peak periods and are generally given lower priority than passenger trains.

- Restrictions on the operating hours of freight terminals, heavy vehicle access to certain roads connecting to freight precincts, and delivery times. The noise generated by freight terminals and trucks mean that local governments may place restrictions on operations, access routes and delivery times to avoid disturbance to surrounding residents.³⁴⁷

The impact of congestion, shared infrastructure, curfews and operating restrictions has been a focus for governments. The New South Wales Government has signalled its interest in working with the Australian Government to develop an outcomes-based approach to managing noise emissions from freight aircraft operating during the Sydney Airport curfew period.³⁴⁸ There have also been significant infrastructure investments, such as the recent commencement of construction of Western Sydney Airport (which will operate 24 hours per day), as well as targeted investment on separate passenger and freight infrastructure.

Finally, governments have increasingly sought to couple infrastructure investment with regulations to force the separation of freight and passenger traffic. In Victoria, there are plans to ban trucks from suburban streets in Melbourne's inner west, forcing them to use the West Gate Tunnel once it is constructed.³⁴⁹ Similarly, the New South Wales Government plans to force trucks to use the NorthConnex tunnel once this is complete.³⁵⁰

77. Challenge

Freight transport in our fast-growing cities is impacted by congestion leading to increased costs.

If this is not addressed, delays in our urban supply chains will become more common and costs will increase as our cities grow.

**When this
will impact:**

0-5

5-10

10-15

15+

**Where this
will impact:**



Meeting the micro-freight challenge

Growth in high-value freight and parcel delivery is being driven by online shopping and an increasingly competitive retail environment. In 2017, online retail sales were valued at \$24.2 billion and were 10.1% higher than the year before.³⁵¹ Online sales are projected to continue to grow rapidly, and could double in value every five years.³⁵²

Customers increasingly expect delivery to their front door or office within a short timeframe. These expectations, combined with growth in the range of courier and delivery businesses aiming to meet

customer preferences, mean there has been significant growth in small freight vehicle movements in higher-density urban areas.

Growth in light commercial vehicles has contributed to increasing traffic congestion. As a proportion of total vehicle kilometres travelled, light commercial vehicle use has grown from about 17.4% (39.3 billion kilometres annually) in 2007-08 to 20.4% (54.0 billion kilometres annually) in 2017-18 (Figure 34).³⁵³

This growth not only leads to more traffic on our roads, but causes congestion of kerbside parking and loading zones, particularly in high-density areas like CBDs.

A key challenge for local and state governments is to balance the growth in micro-freight with other important policy initiatives. For example, local governments are rightly putting greater emphasis on improving the liveability and walkability of urban centres. This can impact the movement of freight, as improving liveability often means giving priority to pedestrian movements over vehicles.³⁵⁴

There is also a challenge in ensuring statutory and strategic planning frameworks are aligned. Local planning guidelines and development assessment processes may not encourage strategic approaches that consider solutions across broader areas and/or multiple land use functions. This means that opportunities are being missed to deliver improved spaces for freight operations, such as off-street loading zones. Planning reforms and initiatives to provide information and advice on freight to land-use planners can therefore have a big impact on long-term freight efficiency.³⁵⁵

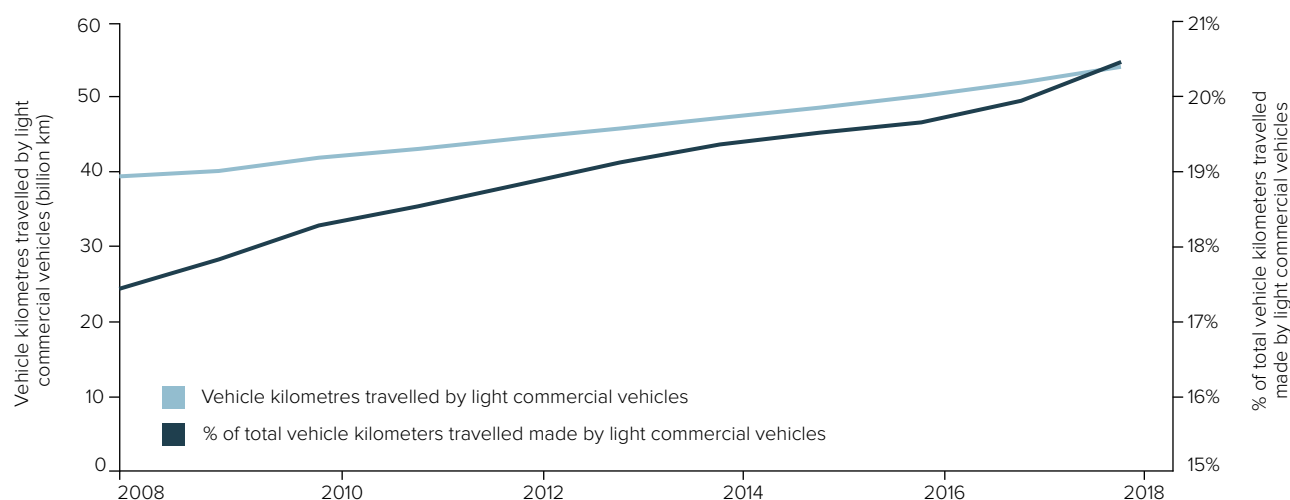
The rapid growth in micro-freight activity has also led to challenges for storing and warehousing. Logistics companies increasingly look for strategically placed land to ensure quick and effective delivery from warehouses to key centres of demand, but this land is often scarce.

In eastern Sydney, for example, the proximity of the airport and port to the CBD and inner city suburbs makes the area an ideal location for distribution centres and warehousing. However, only 3% of industrial or urban services zoned land in the area is undeveloped, and vacancy rates are at record lows.³⁵⁶ The result is that logistics companies are forced to move further away from their key demand and supply centres, placing more pressure on the transport network.

Governments have recognised the growing challenge of catering for micro-freight. Some jurisdictions have recently investigated or trialled courier consolidation centres and the forced retiming of deliveries to support the more efficient servicing of local businesses, including in areas disrupted by the construction of major infrastructure projects.³⁵⁷

In addition, the potential role of technology in addressing micro-freight issues is substantial. Drones are already being explored by freight operators, logistics firms, Australia Post and even fast food restaurant chains as a mode to deliver small consignments quickly. Regulatory issues remain a potential roadblock, but there is potential that this mode will become an important part of the freight mix, particularly in micro-freight, in the future.

Figure 34: Vehicle kilometres travelled by light commercial vehicles grew over the last decade



Source: Bureau of Infrastructure, Transport and Regional Economics (2018)³⁵⁸

78. Challenge

An increase in deliveries by light commercial vehicles is contributing to road and kerbside congestion, particularly in inner urban areas. This is driven by growth in online shopping and changing consumer expectations about timely and door-to-door deliveries. Without action, light commercial vehicles will make a growing contribution to congestion in major employment centres.

When this will impact:



Where this will impact:



5.12 Ensuring the national freight network is effective and efficient

At a glance

This section covers:

- Stalled progress in the move towards further uptake of high productivity vehicles
- New technologies that the sector can take advantage of in coming years
- Fragmented network regulation and how it affects transport operators
- Truck safety issues and how governments can act to reduce road fatalities.

These issues are interconnected. While new tools such as in-vehicle telematics can greatly improve safety outcomes, regulation governs the uptake of new technology.

Freight network regulation and access conditions are fragmented

Regulations controlling access to Australia's freight network are fragmented, inefficient and confusing for transport operators. Australia's freight networks have historically been managed and regulated by different levels of government. State governments have traditionally played the greatest role by regulating access to road networks as well as urban and most regional railways. However, the role of the states intersects with Commonwealth regulation of the interstate rail network, airports and some functions at ports. Local governments also have an important role to play in managing heavy vehicle access to local roads, particularly in regional areas. The result is inconsistent access regimes, standards and safety regulations across jurisdictions and between different levels of government.

In 2011, the Australian Government and states and territories agreed to establish a national system of freight regulation encompassing the uniform regulation of rail (safety), maritime (domestic commercial vessel safety) and heavy vehicles (access and safety). National regulators commenced operation in 2012 and relevant regulatory services that were historically performed by the states have been progressively transferring to national bodies.

Despite the progress, accessing our freight networks and crossing jurisdictional boundaries continues to be a complicated and at times costly task for transport operators.

Heavy vehicle safety and access regulation is in a slow state of transition. The Heavy Vehicle National Law commenced in 2014, and in its current state is not so much a single national law as a merging of various highly prescriptive, jurisdictional laws with many variations in requirements. These law is as a consequence currently inconsistent in its approach and difficult to read and interpret for both industry and the regulator.³⁵⁹ These issues have been recognised by governments, and in May 2018 transport ministers agreed to a review of the Heavy Vehicle National Law, led by the National Transport Commission.³⁶⁰

Inconsistency in regulations can have significant impacts on costs for road transport operators, which are ultimately passed on to consumers. It can also lead to a limited take-up of higher productivity vehicles, meaning road transport becomes less efficient than it could be.

While the rail industry, with its different track gauges, is traditionally used as an example of inconsistency between states, it is arguably more advanced than the road sector in regard to harmonisation. Australia now has a standard gauge national network and a single national rail safety regulator. Nevertheless, operational and regulatory inconsistencies remain.

The rail networks themselves are managed by various government and private sector organisations. In New South Wales, for example, rail operators transporting containerised freight from regional New South Wales to Port Botany typically travel over networks managed by three separate network managers.³⁶¹

Both standards and forms of technology vary across networks. This can result in costs and inefficiencies for train operators. Costs can be associated with duplicated effort in meeting various standards, additional training of staff for different geographical areas, and more time spent complying with the requirements of each network.³⁶²

The task for governments is to ensure that the regulatory, access and operational environment across our land transport networks achieves an optimal level of harmonisation. This does not necessarily mean consistency across all contexts in all circumstances. In the case of roads, it is perfectly reasonable that some roads will not be able to handle the same weight and size vehicles as others. Similarly, for rail, the costs to operators of inconsistent regulation or standards may be outweighed by the costs of achieving full consistency across the network.³⁶³ The challenge for governments and regulators is to strike a balance between the costs and benefits of regulation to transport operators, taxpayers and the community.

Finally, the regulation of coastal shipping creates a range of administrative issues for logistics companies, including licence applications and restrictions on the number and type of journeys that can be undertaken by ships, and the working rights of international

seafarers.³⁶⁴ Coastal shipping currently moves about 15% of Australia's domestic freight task and, given Australia's vast distances and extensive network of ports, has the potential to be more competitive with road and rail.³⁶⁵

79. Challenge

Inconsistent regulations, standards and technologies across our road and rail networks increase costs for transport operators and agricultural producers, which are ultimately passed on to customers. Without action, costs and time spent complying with regulation will remain unnecessarily high, reducing the productivity of our supply chains.

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Where this will impact:



High productivity vehicles have limited access to our road network

Domestic supply chain productivity is vital for both Australian consumers and exporters. High productivity vehicles are truck and trailer combinations that carry more mass or volume than traditional smaller freight vehicles. When transporting more volume these vehicles can reduce total required vehicle movements (and, in turn, congestion growth), lower the costs of freight and enable faster delivery times, with wide overall productivity benefits.³⁶⁶ The need to maximise freight volume is a major driver for the use of high productivity vehicles on long-haul routes delivering consumer goods, while additional mass is a priority for the transport of liquids and other bulk goods. A major consideration for the regulators of these vehicles is their impact on the life of road assets, traded off against productivity benefits.

Regimes governing the use of high productivity vehicles also extend to the use of specialised equipment such as mining, farming or construction vehicles. While these may have fixed dimensions beyond the limits generally imposed on vehicles given unlimited access to the road network, their controlled access is essential for them to reach their place of use.

Compared to conventional trucks, high mass and volume vehicles have the potential to be safer, quieter and less emissions-intensive.³⁶⁷ Austroads found that high productivity vehicles had 76% less accidents compared to conventional trucks.³⁶⁸ High productivity vehicles generate cost savings to operators and customers. These benefits have been forecast to deliver flow-on economic benefits to the community of around \$5.7 billion between 2014 and 2030.³⁶⁹ Benefits are particularly on offer to smaller

cities and regional centres and between sites of primary production, regional manufacturing facilities and ports.³⁷⁰

Despite their benefits, the use of high productivity vehicles on our roads has been limited. Their access to metropolitan roads is restricted. They face community concerns about the length of the vehicles, the need for infrastructure upgrades to facilitate their use,³⁷¹ and regulation that safely and quickly permits their operation. Community concerns are often based on incomplete or incorrect information. The use of new safety technology, such as fatigue and blind spot monitoring, could further improve the performance and community acceptability of high productivity vehicles.

Beyond safety improvements, high productivity vehicles stand to also benefit from technological advancements in vehicle propulsion. New hydrogen-powered heavy duty trucks can operate at a ranges of up to 1,200 km, and are currently in development for markets in the United States and the United Kingdom.³⁷² Currently electric vehicle technology is available for small trucks but not suited to high mass vehicles.³⁷³ Recent advancements have led to the limited roll-out of this technology for specialised uses, such as waste vehicles, and indicated the potential for its future application to higher mass vehicles.³⁷⁴

There is demand from industry for governments to facilitate the more widespread use of high productivity vehicles. Heavy vehicles are regulated by national Performance-Based Standards, which set requirements for a vehicle's on-road performance. To apply these standards, regulators are tasked with assessing each vehicle type for its impact on road assets, such as road pavement and intersection infrastructure, and its compliance with a common set of safety standards.

In 2014-15 applications for Performance-Based Standards enabling the use of high productivity vehicles rose up by 115% over 2013, while Performance-Based Standards applications for all heavy vehicles rose by 82%.³⁷⁵ A series of challenges need to be considered by operators requesting Performance-Based Standards vehicles. For example, if the road network is not designed for use by high productivity vehicles, available rest bays may be too small for them.

There are broader benefits and risks associated with high productivity vehicles. For instance, a larger prime mover may allow larger sleeping

accommodation behind the driver's seat. Making use of this can reduce driver fatigue and improve safety outcomes.

While progress has been made by the National Heavy Vehicle Regulator, there are concerns about the lack of coordinated policy initiatives to promote high productivity vehicles' access to the road network. Time-consuming and costly case-by-case decision-making on access permits can discourage the uptake of high productivity vehicles as well as imposing costs on the operators of over-dimension specialised equipment needing regular and timely access to the road network.³⁷⁶

High productivity vehicles face barriers to adoption

The Heavy Vehicle National Law defines how heavy vehicles can access road networks in all jurisdictions with the exception of Western Australia and the Northern Territory. Heavy vehicles can be broadly categorised as either a General Access Vehicle or a Restricted Access Vehicle.

General Access Vehicles are trucks which comply with dimensions set by the national law. Restricted Access Vehicles exceed national law dimensions. These vehicles include a wide variety of longer and/or heavier high productivity vehicles, including B-doubles and B-triples as well as non-standard vehicle types.

Many Restricted Access Vehicle operators are required to apply to road network managers for access on a case-by-case basis. The National Heavy Vehicle Regulator now manages this process in the eastern states and South Australia, coordinating with state and local government network managers. However, even under the national regulator, there are long-standing

differences in state and territory rules about permissible weight limits.

Inconsistent regulations can limit the efficiency of operators, either by making them take circuitous routes, or by forcing them to use inefficient vehicle combinations. Indeed, heavy vehicle operators report having to choose between using vehicles which meet all standards along the different sections a route (thereby meeting the most restrictive of standards) or decoupling high productivity vehicles outside restricted areas and moving trailers separately.³⁷⁷

The additional costs under either approach can be substantial. For example, cattle producers in Longreach, Queensland, when transporting their cattle to Brisbane need to break their vehicles into smaller combinations twice, once at Roma and again at Toowoomba. If they were able to use a B-double for the entire journey, transport costs could be reduced by about 37%.³⁷⁸

80. Challenge

High productivity vehicle use is limited by community sentiment as well as physical and regulatory impediments to access to our road network. Restricted use of high productivity vehicles will lock in high freight costs for businesses and consumers, and limit benefits to road safety, air pollution and amenity.

When this will impact:

0-5

5-10

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Where this will impact:



Supporting freight innovation and new technology

Freight transport and logistics are particularly well positioned to take advantage of technological developments, because the sectors handle many repeated and predictable movements of cargo between established origins and destinations (such as ports and intermodal terminals). These sectors also undertake repetitive warehousing, storage and administrative tasks that can be digitised and automated.

Automation is already important to the industry and digitisation is playing a growing role in record-keeping and the streamlining of operations. In the United States, through improved use of data and analytics, some shippers have reduced warehousing costs by up to 30% and administrative costs by 80%.³⁷⁹

However, perhaps the most significant technological development for the freight transport sector is the roll-out of autonomous vehicles. In Australia, driverless trains started operations in 2018 in the Pilbara,³⁸⁰ and governments are undertaking trials of autonomous passenger road vehicles around the country.

Although the public's focus is often on the impact of autonomous vehicles for passenger transport, it may be felt most profoundly in freight. In Europe, it is estimated driverless technologies and digitisation could reduce trucking costs by up to 47% and

delivery lead times by 40% by 2030.³⁸¹ Similarly, fully autonomous trucks in the United States could reduce operating costs by 45%.³⁸² These decreases in operating costs could lead to significant reductions in the retail price of consumer items as well as improved profits for exporters.

Key existing and emerging technologies and their potential impact on the freight and supply chain sector are summarised in Figure 35.

It is uncertain which innovative transport technologies will be most successfully scaled up for freight use and how they will impact on supply chains. One of the few certainties is change itself. The key for governments in Australia will be to ensure that we remain internationally competitive by enabling and encouraging a greater use of technology, while deploying appropriate regulations to minimise the negative impacts of new technologies on safety, the environment and other transport activities.

Another important role for government will be to ensure that those currently working in the freight sector are not left behind by technological advances. Government has a key role to play in not only providing a safety net to protect existing workers who are experiencing the effects of transition, but also in ensuring our education system prepares future workers to take advantage of technological change. The challenge for governments will be in defining their role in relation to changing labour and production markets during this period of rapid and even exponential change.

81. Challenge

The pace and impact of technological change on our supply chains is uncertain. Governments face dual challenges of enabling private sector innovation while also regulating to ensure change does not harm the community. If governments do not intervene appropriately, innovation could be stifled or, alternatively, technological development could pose safety and environmental threats.

When this will impact:

0-5

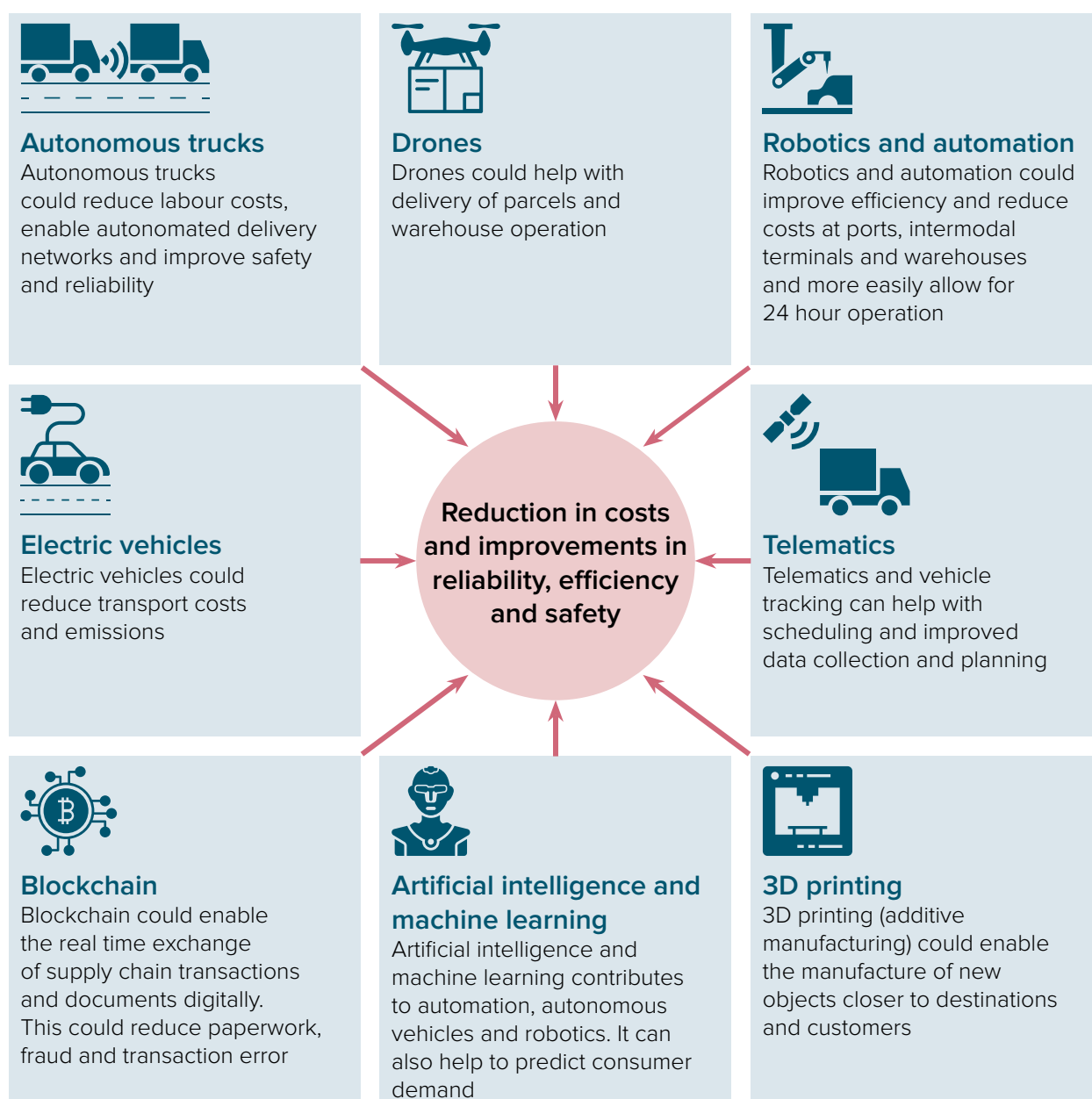
5-10

10-15

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Where this will impact:



Figure 35: The potential impact of existing and emerging technologies on freight transport and logistics

Source: Based on Transport for Victoria (2018)³⁸³

Safe trucks can save lives and money

Road freight has the highest fatality rate of any industry in Australia, and the highest rate of serious injury claims.³⁸⁴

The rate of fatal crashes involving heavy trucks decreased by an average of 4.1% per year over the three years to March 2019.³⁸⁵

The recent decline in the overall number of fatal crashes involving heavy vehicles is a positive development, but the absolute number of lives lost on our roads remains a major concern.³⁸⁶

During the 12 months to the end of March 2019, 163 people died from 147 fatal crashes involving heavy trucks.³⁸⁷

In the absence of other changes (such as safer vehicles, roads and drivers), growth of the freight task increases the general risk of crashes involving heavy vehicles. Safety risks associated with rigid trucks and light commercial vehicles will be a particular challenge given continued growth of the urban freight task, including micro-freight driven by e-commerce.

State and territory governments invest significantly in road safety initiatives including campaigns targeting trucks.³⁸⁸ There is also a high degree of coordination between jurisdictions on road safety. In September 2017, the Australian Government announced the commencement of an independent Inquiry into the effectiveness of the National Road Safety Strategy 2011–2020. The Inquiry panel provided its report and recommendations in September 2018. Key recommendations included:

- Establishing a national road safety entity to report to a Cabinet minister with specific multi-agency responsibility to address road trauma
- Committing to a minimum \$3 billion a year road safety fund
- Accelerating the adoption of speed management initiatives that support harm elimination.³⁸⁹

Transport ministers have agreed to progress the report's recommendations and all jurisdictions have agreed to work with the Australian Government to develop an implementation plan.³⁹⁰

Many road freight operators are also independently active in improving road safety. Safety technology such as in-vehicle telematics is being used by large sections of the industry.³⁹¹ Telematics is a method of monitoring vehicles that combines GPS with on-board diagnostics so that a vehicle's speed and location, driver hours and other information can be remotely viewed. Numerous transport companies, such as Toll and Linfox, have either fitted telematics to their fleets or will ensure all new vehicles are fitted.

Although measures to improve safety may have a upfront cost, they can lead to substantial efficiencies in other areas. For example, the use of telematics allows companies to monitor and provide feedback to drivers about harsh braking, over-revving and speeding, as well as data on truck fuel consumption, route optimisation and improved fleet maintenance.³⁹²

Despite the potential benefits of technology, the uptake of telematics and other safety features, such as autonomous early braking and lane departure warnings, remains low.³⁹³ The majority of Australia's heavy vehicle operators are small businesses. About 70% of operators have only one truck in their fleet, and 24% have two to four trucks. The upfront costs of sophisticated safety technology, particularly for smaller operators with lower margins, is a significant disincentive.

The Transport Infrastructure Council, the key Ministerial forum for the sector under the Council of Australian Governments, is investigating a national approach to heavy vehicle accreditation schemes to improve the capacity and uptake of telematics for businesses.³⁹⁴ This provides an opportunity to consider outcomes-based regulation, which could improve safety and minimise red tape for industry. The challenge will be to encourage the adoption of technology for safety, while also recognising that different businesses have a varying capacity to meet upfront costs.

82. Opportunity

New technologies can help improve road safety and efficiency, but they have upfront costs that mean uptake rates remain low. Increased use of technology could improve road safety.

When this will impact:

0-5

5-10

10-15

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Where this will impact:



5.13 Unlocking regional economic development through freight

At a glance

Freight transport is critical for remote and regional communities. Poor infrastructure in some areas can constrain industry and limit economic development.

This section explores how targeted investment in these areas can strengthen industry and open up new markets. It also looks at the issues existing road and rail networks face.

Freight transport is critical for regional and remote communities

Remote and regional areas make a substantial contribution to the Australian economy. Between 1989 and 2018, regional New South Wales, Victoria, Queensland, South Australia and Western Australia, together with Tasmania and the Northern Territory, collectively contributed 32% of Australia's GDP growth.³⁹⁵

The primary production (pastoral activity, horticulture and agriculture, carbon farming, fisheries and aquaculture) and mining sectors are critical to Australia's economy, and especially to remote and regional communities. The mining sector alone

accounts for about 8% of Australia's gross value added (the contribution to our economy before accounting for taxes), having grown its share by a third in the last 10 years. While agriculture, forestry and fishing have not experienced the same growth, they remain a crucial part of the economy, accounting for about 3% of GDP.³⁹⁶

Despite this significant contribution, the relatively poor standard of transport infrastructure in some remote and regional areas can constrain mining and agricultural operations and their access to markets, and therefore is likely to limit long-term economic development in remote and regional areas,³⁹⁷ and the Australian economy as a whole.

Parts of northern Australia suffer from low-quality infrastructure

In its report to the Parliament of Australia in September 2014, the Joint Select Committee on Northern Australia identified that industries and communities in northern Australia are heavily reliant on the road network, with few alternative routes in the event of disruption to network links; for example:

- In northern Western Australia, the Great Northern Highway is the only sealed road linking the Northern Territory with other centres in Western Australia.
- The Northern Territory has only five major sealed roads outside Darwin.
- Queensland has a more extensive highway system but there is heavy reliance on access roads that are not highway grade or are frequently flooded.
- Railway networks and port connectivity in the north are considered by many key stakeholders operating in the region to be underdeveloped.

- The Kimberley region does not have railway lines – railways in the north-west region of Western Australia are not connected to the rest of Australia and there is no railway between the Northern Territory and Queensland. Limited rail options can put further pressure on road networks, depending on the size and nature of the freight task.

Similar challenges are faced in outback remote areas of South Australia. The South Australian Government manages approximately 10,000 km of roads in unincorporated areas of the state. The majority of these roads are unsealed and include key outback routes (the Birdsville, Strzelecki, and Oodnadatta tracks) linking key centres in remote and very remote South Australia and providing access for communities, tourism, mining and pastoral activities.

Source: Transport and Infrastructure Council (2015)³⁹⁸

The movement of mining products is a key aspect of regional freight. Australia hosts some of the world's largest mining areas, including the Pilbara iron ore province (the Pilbara region is responsible for almost one-third of the world's iron ore production), Bowen Basin coalfields, Argyle Diamond Mine, Mount Isa lead-zinc province and the world's largest manganese mine at Groote Eylandt.³⁹⁹

In the Pilbara region of Western Australia, the larger mining companies, including BHP Billiton, Rio Tinto, Fortescue Metals Group and Roy Hill Holdings, own and operate their own railways, which carry iron ore directly from their mines to port for export. In Queensland, the coal rail networks are managed by the privately-owned Aurizon Holdings. The only publicly-owned coal network is the Hunter Valley Coal Chain in New South Wales, government-owned and managed by the Australian Rail Track Corporation but coordinated with the support of strong industry investment.⁴⁰⁰

These supply chains transport some of the largest mineral volumes in the world. For example, Port Hedland in the Pilbara is the world's largest bulk export port. In addition, Newcastle is the world's largest coal export port,⁴⁰¹ and our railways carry some of the world's heaviest and longest trains.⁴⁰² These supply chains generally recover their costs and so operate without government subsidy. Governments' role here is to focus on minimising regulatory red tape or other obstacles to the continued efficient functioning of operations, while also ensuring competition, safety and environmental standards are met.

The scale, diversity and geographic spread of Australian agricultural activity, and the large number of operators, means that agricultural supply chains are complex from both an infrastructure provision and a governance perspective. The agricultural supply chain carries large volumes of relatively low-value commodities, such as wheat and barley, as well as livestock, horticultural and dairy products where cool storage and timely transport can be important.

While the supply chains taking producers' goods to market is rightly a focus here, equally important are the transport chains operating in the opposite direction. These supply chains keep our farms and mines working by delivering key inputs such as fuel, construction materials, machinery and spare parts, bulk chemicals, fertilisers and pesticides.

These inward flows of freight are critical to supplying our regional and remote communities with basic needs such as food, clothing and household items. Remote communities can be particularly vulnerable because there are often limited ways to access them. Natural disasters, which can close, and in some cases destroy, remote transport infrastructure can cut off communities from critical supply chains for extended periods.

The complexity and diversity of supply chains, combined with the vulnerability of remote communities, mean government has a role in subsidising supporting infrastructure. This role can be particularly problematic for remote roads and regional airports, where local governments are largely responsible for maintenance costs, but often lack the necessary funding. For example, over 60% of regional airports currently operate at a loss and about 40% expect to continue operating at a loss in the foreseeable future.⁴⁰³ Similarly for roads, regional and remote networks are extensive, and local governments have limited opportunities to raise enough revenue to fund and maintain them. In New South Wales alone, it is estimated there is a local road maintenance backlog of \$2.2 billion, with regional councils' accountabilities making up 75% of this.⁴⁰⁴

The increased use of drones offers beneficial opportunities. Existing regulation limits drone use beyond visual line of sight from a remote operations centre. In the mining sector, drones can be used for tasks such as surveying, stocktaking, photogrammetry, LiDAR (Light Detection and Ranging) scans and road inspections.⁴⁰⁵ For remote towns and villages isolated by floods or other conditions, drones can fulfil the urgent delivery of essential freight such as medication.

83. Challenge

Remote and regional supply chains are critical for industry and to supply communities with basic needs. However, local governments often struggle to fund and maintain critical transport infrastructure. If this is not addressed, our agricultural supply chains and regional and remote communities will be vulnerable to delays, higher costs and extreme weather events.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:





Freight investment can be a catalyst for regional development

In Australia, supply chain costs represent around 10% of the final cost of a product, a cost ultimately borne by the consumer.⁴⁰⁶ Investment in the planning, delivery and management of infrastructure, including its governance, can help to reduce the costs of freight movements. Some of this can be dealt with by actions focused on urban issues but, given the significance of the regionally based mining and agricultural sectors, the importance of programs at the local and regional levels cannot be overstated.

A community's economic prosperity is linked to its access to markets.⁴⁰⁷ This allows businesses to reach their customers, as well as attract appropriately skilled labour. Given the size of Australia and the distances between regional and remote producers and their markets, the transport network is central to communities' economic wealth.

If infrastructure investments are appropriately targeted, planned and supported by a robust business case, they can reduce transport times, increase safety and improve reliability. This can reduce the costs of both moving mineral and agricultural produce to market and bringing supplies to farms, mines and regional towns.

Beef roads program – promoting regional development in northern Australia

The Australian Government announced projects to be funded under the Northern Australia Beef Roads Program in October 2016.

The \$100 million program is making targeted upgrades to key roads necessary for transporting cattle, to improve the reliability, productivity and resilience of cattle supply chains in northern Australia, thereby reducing freight costs and strengthening links to markets.

The CSIRO analysed and modelled different scenarios put forward by state, territory and local governments using its Transport Network Strategic Investment Tool (TraNSIT) to determine the extent of benefits to the movement of cattle and assist in the prioritisation of projects. Through that process, a series of 18 road-sealing and lane-widening projects in northern Queensland, Western Australia and the Northern Territory have been initiated.

At the local level, infrastructure investments can have a major impact, stimulating the growth of existing and new industries and opening access to new markets for those industries.

Various state governments have introduced programs to support the delivery of new infrastructure, targeted at improving economic conditions for regional communities. Queensland has the Building Our Regions Program, providing \$445 million for local government infrastructure projects, and much of Western Australia's Royalties for the Regions Program is dedicated to localised infrastructure. New South Wales has created the Office of the Regional Infrastructure Coordinator for the same purpose.

However, there are also challenges to leveraging freight investments for regional development. The freight transport sector is complicated, and any infrastructure investment may require the involvement of several levels of government, infrastructure managers and private sector freight operators. As a result, it can be difficult to ensure different organisations and aspects of a project are sufficiently coordinated to maximise the benefits to its region.

For example, a federally funded upgrade to a highway may reduce transport times along a trunk freight corridor. However, it may not help local producers or industry if it is not coordinated with upgrades to local access roads, appropriate regulatory changes and local rezonings to ensure industry and producers can locate nearby.

Inland rail and Parkes, New South Wales – planning for regional development

The town of Parkes is located in the Central West region of New South Wales. The town is in a strategic position because it is at the confluence of the north-south Newell Highway and the east-west interstate rail line from Sydney to Perth, with links to Adelaide and Darwin. It can handle B-double access on all routes, and road trains or B-triples and double-stacked trains in a westerly direction. It will be the location for a terminal on the Inland Rail line, with the first trains set to be operating in 2024-25.

The Inland Rail Project potentially offers a range of benefits for the Parkes region, including:

- Attracting nearby agricultural products into local storage and supply chains

- Building on the network of existing interstate intermodal freight terminals, establishing the area as an efficient, national distribution hub for specific high-value, low-speed and high-mass goods.

However, the Inland Rail Project alone will not deliver these benefits, and the New South Wales Government is therefore facilitating the development of a Special Activation Precinct, a new industrial area which will concentrate freight and logistics activities, including an inland port west of the town. The Precinct's design – structure plan layout, infrastructure, incentive structure and governance arrangements – is intended to drive economic development by creating new, high-productivity activities in freight logistics and agriculture.

84. Challenge

The complexity of the freight sector means leveraging infrastructure investments to maximise regional development can be challenging. Without improved coordination between jurisdictions, infrastructure managers and freight operators, regional development opportunities will be missed.

When this will impact:



Where this will impact:





Bottlenecks exist in our agricultural supply chains

Capacity bottlenecks in our agricultural supply chains are common, particularly in bumper crop years, where the volume of commodities to be transported can be well above average.

Our regional rail networks in particular face substantial challenges and capacity constraints. Australia's grain rail lines offer variable infrastructure quality across networks, which can result in slower speeds, choke points and the need to switch from mainline to branch line locomotives.⁴⁰⁸

The poor quality of grain railways, particularly branch lines, means they are not resilient, and are especially vulnerable in bumper crop years, when they can fail to offer sufficient capacity and become unreliable. This can substantially increase costs for producers and result in lost revenue.

Freight rail networks are expensive to build and maintain, and serve highly variable and seasonal traffic. The location of the older grain silos and sub-terminals on a freight rail network make it hard for the network to meet contemporary demands for the provision of just-in-time grain volumes to ports for export. Overall the private sector may find it difficult to financially justify construction and maintenance costs.

As a consequence, most regional grain lines require government subsidy to remain open. In some states,

regional branch lines have had to be consolidated and some lower-capacity rail lines have been closed and replaced by high-capacity trucks, which are considered to be more cost-effective.

Roads are more flexible than rail, and are better able to respond to seasonal variability. They are also usually more cost-effective in servicing freight activities that operate over dispersed geographies and carry lower volumes.

However, the switch to road can be problematic. Trucks also face capacity constraints through regulatory limitations on road access. Rail-based silos and sub-terminals may be relatively inaccessible to larger vehicles. In addition, truck movements pose greater safety risks than rail and produce higher emissions.

While consolidating regional railways may be a reasonable economic decision because of the lower cost of roads, it is often an unpopular choice with local communities.

Closing rail lines also shifts the costs of infrastructure maintenance to the local road manager. In regional areas, this is often local governments, who can struggle to meet the cost of maintaining their networks.⁴⁰⁹

Governments therefore face challenging decisions when it comes to investing in regional freight infrastructure. Financial performance, infrastructure capacity, community expectations, safety and environmental performance all need to be balanced.

The cost of unreliable rail infrastructure

The 2016 to 2017 grain harvest in Victoria was particularly strong. However, most of the state's grain was transported by road instead of rail that year, reversing a recent trend towards rail carrying about 60% of the state's grain. Hot weather and lower-capacity lines meant restrictions were placed on some of Victoria's grain lines.

The restrictions had significant commercial impacts. Emerald Grain advised that because of 'take-or-pay' contracts, commonly used in the rail industry, they were forced to pay for rail transport that they could not use, as well as paying for additional road transport.⁴¹⁰

Lower tonnage grain railways in Western Australia have been closed

Up to half of Australia's grain exports come from Western Australia, and about 60% of grain in that state is carried to port by rail.

Arc Infrastructure manages the Western Australian grain network as an open access, multi-user asset. The organisation manages track access negotiations with end-users and train operators and is responsible for track infrastructure and train control services. Arc Infrastructure holds a lease over the railways from the Western Australian Government until 2049.

Between 2013 and 2014, Arc Infrastructure (then called Brookfield Rail) made the decision to close about 500 km of 'tier 3' rail lines. The closed rail lines were mainly lower tonnage railways that carried trains to main lines and subsequently to ports.

The reason for closing the lines was that they were found to be uneconomic and it was considered cheaper to instead direct funding to roads for grain transport. Arc Infrastructure notes the lines could have remained operational had an above-rail customer been willing to cover the required maintenance costs.⁴¹¹

There was significant community opposition to the closure of the rail lines, with community groups claiming roads had not been sufficiently upgraded and maintained. Some farming groups as well as the Co-operative Bulk Handling Group have argued that line closures have increased their costs and reduced access to the grain supply chain.⁴¹²

85. Challenge

Highly variable and seasonal traffic can make investment and maintenance of regional grain railways difficult to justify. This results in bottlenecks, speed restrictions, lower capacities and sometimes line closures. If this is not addressed, producers and transport operators will continue to incur higher costs and delays, particularly in high harvest years.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



5.14 Transporting, storing and making the most of our waste

At a glance

Australia is one of the world's largest waste producers per capita, but our waste management is often poorly planned.

This section examines the increased pressure on the sector as demand grows and infrastructure shrinks. Key challenges are:

- Inconsistent regulation that has created distinct waste markets in each state and territory
- The need for local governments, investors and researchers to work more closely on innovative infrastructure solutions
- The inconsistent delivery of waste services outside our cities, leading to inefficiencies and higher costs.

The section considers technological change, and how alternative fleets can reduce consumer costs and noise.

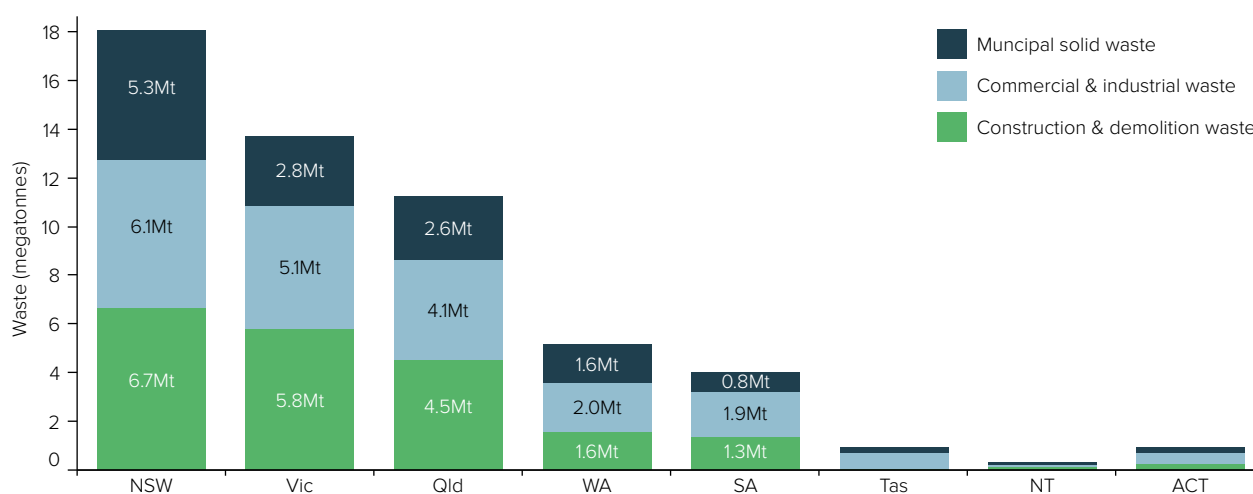
Australia is one of the world's largest waste generators per capita

Waste management is an essential public service, like energy and water. However, the waste infrastructure required is often pushed to the periphery or not well considered in land use planning, zoning and design. Integrated, secure and cost-effective waste infrastructure is required to meet the long-term needs of Australians, who are among the largest generators of waste per capita in the world.

In 2016–17, Australia generated an estimated 54 megatonnes of waste, equivalent to 2.2 tonnes per capita.⁴¹³ While on par with other developed countries in total terms, household waste generation per capita is 9% above the average for a selection of 11 European and south-east Asian countries.⁴¹⁴ With a projected population of 37 million people in 2050,⁴¹⁵ our annual waste could rise to 81 megatonnes per annum.

Waste volumes broadly mirror the population in each state and territory (Figure 36), with some variations based on income, economic mix, community attitudes and the availability and cost of waste infrastructure, as well as policy and regulation.

Figure 36: Australians are generating large amounts of waste



Source: Department of the Environment and Energy (2018)⁴¹⁶

Waste volumes have historically been approximately evenly divided between the three core waste streams of municipal solid waste, commercial and industrial waste, and construction and demolition waste. However, unprecedented levels of investment in housing and civil infrastructure have generated record volumes of construction and demolition waste in recent years.⁴¹⁷ Municipal solid waste, and commercial and industrial waste, have grown more slowly.

At the household level Australians are relatively enthusiastic recyclers and recovered 62% of waste materials through recycling and energy recovery in 2016-17, a modest increase from 55% in 2006-07.⁴¹⁸ However, the strong culture of recycling and reuse seen in some European countries has not developed. For instance, countries such as Denmark (94%) and the United Kingdom (75%)⁴¹⁹ have a significant focus on waste reduction and of reprocessing waste that is created including through energy recovery from waste.

Australia has relies on conventional recycling and exports of recyclables to Asia. As the waste Australia generates increases, our traditional methods of disposing, transporting and exporting waste are being forced to change by market conditions and community expectations.

Waste management is an essential service under growing pressure

Australia's \$15.5 billion waste industry grew from the need to safeguard public health.⁴²⁰ Today it also responds to the environmental aspirations of Australians and is a key actor in the transition to a circular economy that reuses materials where possible, and recovers value from other discarded materials.⁴²¹

Each form of waste is associated with varied supply chains, processing facilities, transport methods and regulatory frameworks. Waste is generated in every home, building, business, institution, construction project and public place. Volume and ubiquity make waste management one of the largest freight tasks in any city, with Transport for NSW estimating that waste accounts for more than 10% of Sydney's freight task.⁴²²

It makes the waste industry, in part, a logistics business that aims to provide efficient collection

and transport services for end-of-life materials.

Transport infrastructure is a critical factor in the cost and efficiency of waste service delivery, impacted by congestion, fuel and road toll costs and the growing distances over which waste has to be transported from its point of generation. Away from our cities, the cost of transporting recoverable materials to market can be a significant constraint on diverting waste from landfill.

Closely linked with transport is the network of waste management infrastructure in each city, town or region. Transfer stations aggregate waste into larger trucks to improve transport efficiency. Recycling facilities sort dry, co-mingled materials into separate streams for reprocessing into new feedstocks, with dirtier grades potentially contributing to energy recovery. Organics recovery facilities compost or digest household garden and food waste with commercial organic waste to create soil enhancers or energy-rich biogas.

Landfills backstop the system by accepting materials that cannot be economically or technically recovered. The level of technology and effort that can be invested in diversion from landfill is heavily influenced by the cost of landfill as well as the availability of end markets for recovered materials. The revenue from these offtake streams are a key component of any business case.

This interlaced network of waste transport, facilities and markets is under pressure on multiple fronts. Australia's over-reliance over the last 20 years on international markets to accept our recyclable commodities has left domestic reuse markets under-developed. That vulnerability was exposed in 2018 when China and neighbouring countries including Malaysia imposed import restrictions on lower-quality recyclable materials including mixed plastic, paper and metals. As a result, local governments in several states had recycling contracts cancelled or renegotiated. Queensland councils are expecting losses of revenue of up to \$7 million in 2018-19.⁴²³ The cost impacts are likely to be worse for regional areas.⁴²⁴ In response, state and territory governments have provided short-term funding to ease pressures on local councils.

86. Challenge

Australia has increasing waste generation, a lack of a mature market for private investment and a reliance on waste export. Without action, our disposal, recycling and transportation of waste will become more costly and environmentally damaging.

When this will impact:



Where this will impact:



Waste companies have sought new overseas destinations and prioritised higher-quality materials for export, but have also stockpiled recyclables or sent these to landfill where no markets could be found. This is due to global recyclable commodity prices falling and disposal costs increasing.

Landfills are themselves under long-term pressure. The exact number of existing landfill sites is unknown. There are estimated to be 600 registered sites and potentially as many as 2,000 unregulated facilities (Figure 37).⁴²⁵ Many landfills have high environmental protection standards, incorporating features such as composite or geomembrane containment liners, landfill gas capture and combustion, and planning for long-term land rehabilitation. However, many smaller regional landfills often do not meet these standards.

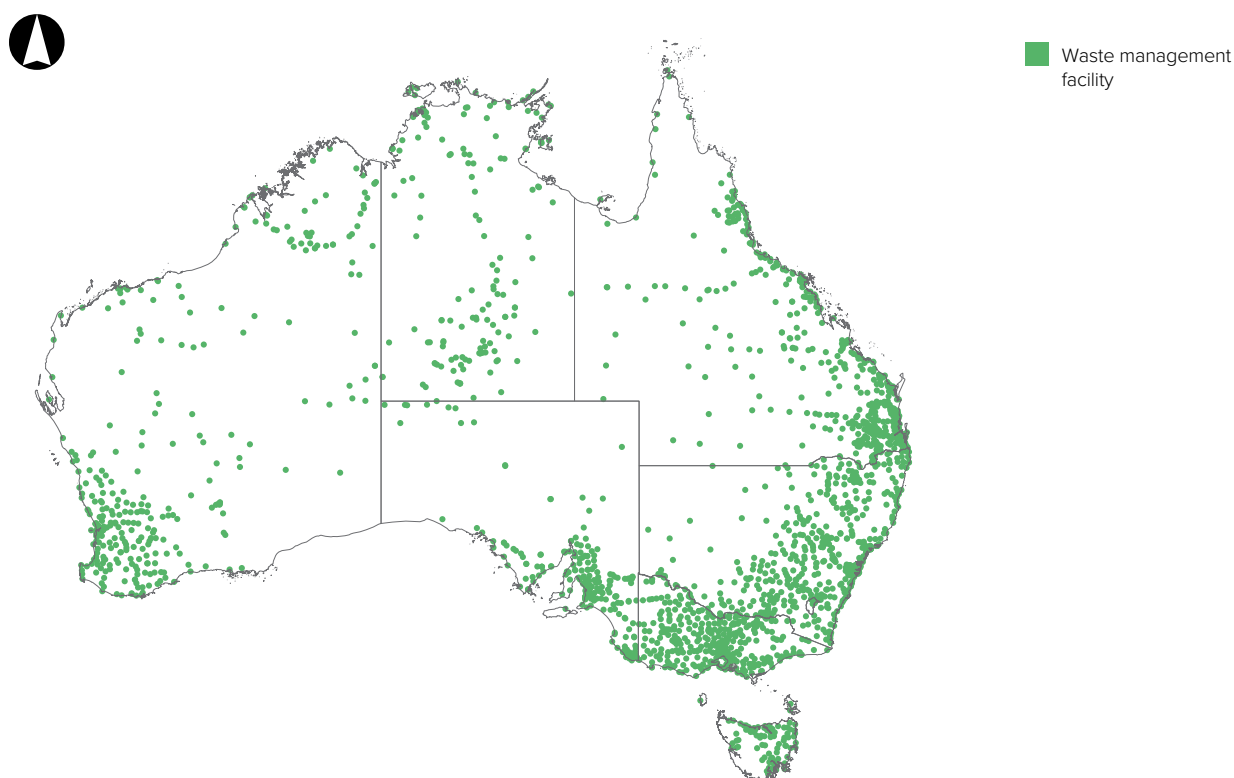
As waste generation continues to increase, few new landfills have been approved and residential development is encroaching on existing sites, threatening their ongoing operation. In Sydney, only one landfill has been approved in the last 20 years, despite the closure of several large landfills in that

time. Major cities are becoming increasingly reliant on a shrinking number of landfill sites, with limited forward planning by governments to identify future disposal capacity. This presents a strategic risk given development approval for a new landfill can take up to 10 years. As accessible infrastructure reaches its end of life, costs are likely to rise and the risks of illegal dumping and stockpiling are likely to grow.

Waste has rarely registered as a major issue for consumers and governments and will be unlikely to do so, as long as kerbside bins have been picked up and affordably removed. For most businesses, waste is a minor cost compared with energy and labour. However, waste has gained prominence in the public conversation since China's recycling restrictions and through television programs such as the ABC's *War on Waste*.

New solutions are needed, yet the market settings required to achieve the best outcomes have been slow to crystallise and more will need to be done to ensure the right mix of waste management and infrastructure assets is deployed.

Figure 37: There are a large number of landfill sites in Australia, but they are under long-term pressure



Source: Geoscience Australia (2019)⁴²⁶



87. Challenge

A limited number of new waste facilities and landfill sites have been approved and residential development is encroaching on existing sites. Without action, waste freight will have to transport their loads further from the waste generation point.

When this will impact:



Where this will impact:

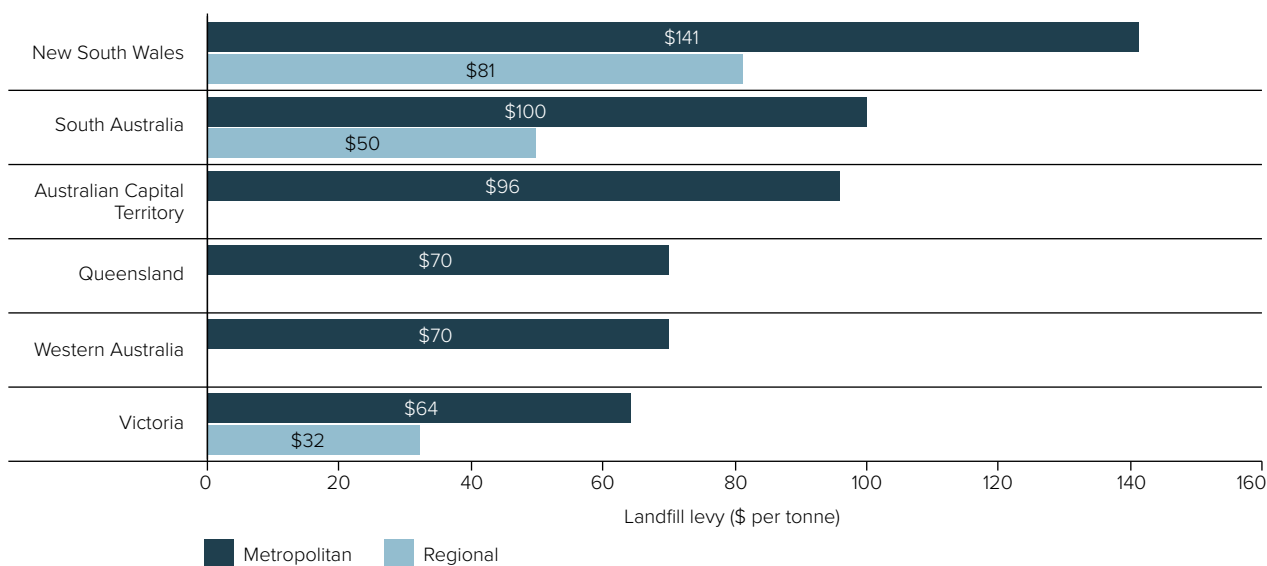


A patchwork of government waste regulations exists

Responsibility for waste management is divided between all three tiers of government. This patchwork of policies and regulations has created distinct waste markets in each state and territory and a raft of unintended consequences, including motivation for companies to transport waste to cheaper outlets thousands of kilometres away.

In 2016–17, for example, an estimated 690,000 tonnes of waste were transported to Queensland from New South Wales metropolitan areas to avoid the latter state's higher landfill levy (Figure 38).⁴²⁷ Significant quantities of hazardous waste are also moved around the country. In some cases this is to receive specialised treatment, but often it is to avoid state levies and restrictive disposal and treatment regulations.

Figure 38: Solid waste landfill levies vary between states and territories, causing waste to flow to the cheapest disposal site



Source: Department of the Environment and Energy (2018)⁴²⁸

The attempted imposition of a proximity principle in New South Wales and hazardous waste regulations in Victoria, forcing waste to be dealt with as close as feasible to where it is produced, failed legally on constitutional grounds. This was because such interventions were considered to be a restraint on trade between the states. The Australian Government has a limited role in waste policy, which has hampered efforts for the national harmonisation of waste regulation. At a state and territory level, change has been slow. Waste regulations are deeply embedded in the history and practice of each jurisdiction, and an integrated approach has not emerged.

At the local level, the task of managing domestic waste in towns and cities is undertaken by Australia's 537 local councils.⁴²⁹ These councils implement state policies, approve design and operating conditions for waste collection, and contract municipal solid waste collection. In regional, remote and rural areas, they also operate key waste assets.

Councils stipulate collection times for all waste operators and typically restrict collection to daytime hours due to noise constraints, even though this means collection often coinciding with the commuter congestion peak. Councils also set the design requirements for new buildings, including the size of waste storage and access for collection. This can be a challenge as urban density grows, because the developers of multi-storey residential and commercial buildings are reluctant to lose floor space in order to provide truck access to underground storage, so bins clutter roadsides on collection day and pose amenity and safety hazards.

The growing need for new infrastructure and innovative solutions

Recognition of the growing pressures on waste infrastructure has prompted action. State and territory governments have commissioned waste infrastructure audits and, in some cases, developed high-level strategies.

Regional councils are exploring and implementing options such as co-collection of food organics and garden organics in a weekly service to produce high value compost. Waste companies are pursuing new commercial opportunities, including the development of processing facilities to create refuse-derived fuel from mixed dry waste. Yarra Valley Water's anaerobic digestion facility is planned to recover energy from 33,000 tonnes of commercial food waste each year.⁴³⁰ In inner Melbourne, a local government initiative has coordinated, consolidated and reduced the impacts of waste disposal and collection.

Investors have also targeted the waste sector for opportunities in the large-scale processing of mixed waste. The first significant waste-to-energy facility to secure full financing was the 400,000 tonnes per annum Phoenix Energy facility in Perth, which in October 2018 announced it had locked in required agreements and \$668 million in capital funding.⁴³¹ The Clean Energy Finance Corporation has estimated that waste-to-energy could provide 800 megawatts of reliable, baseload, low-carbon generation capacity by 2020 and reduce carbon emissions by more than nine million tonnes of CO₂ equivalent per annum.⁴³²

At the other end of the scale, the University of New South Wales in 2018 launched the world's first micro-factory to transform the components from electronic waste (e-waste) items into useful materials including metal alloys and graded ceramics and plastic filaments for 3D printing.⁴³³

The primary technologies for processing mixed waste are outlined in Table 6. These are mature technologies that can be deployed at scale. The table does not include emerging technologies or those focused on niche waste streams, or reprocessing facilities that convert recovered material into useable feedstocks.

88. Challenge

Waste is often transported large distances from where it is generated due to a patchwork of government regulation. Without action, waste will continue to be transported further from the waste generation point adding to congestion and road degradation.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Table 6: Established waste processing technologies

Facility type	Description
Clean materials recovery facility	Facilities designed to separate mixed packaging collected from co-mingled municipal and commercial sources
Dirty materials recovery facility	Facilities that mechanically process mixed waste from various sources to recover recyclables and potentially manufacture refuse-derived fuel
Mechanical-biological treatment	Facilities that mechanically separate mixed putrescible waste, then compost the organic fraction
Thermal treatment and energy recovery facility	Facilities that either combust mixed waste directly or first convert it to syngas (an intermediate product in the creation of synthetic natural gas or methanol) through gasification and recover the energy in various forms
Composting	Facilities that compost garden and food organics, clean wood waste, stabilised biosolids and highly putrescible industrial organics via appropriate options of open windrows, covered and aerated piles or enclosed vessels
Anaerobic digestion	Facilities that digest food organics, food processing waste and industrial and liquid organics in enclosed vessels to generate energy via biogas

Export constraints have also sparked renewed interest in the circular economy, where materials, products and recovery processes are co-designed to cycle materials back into productive use at as a local a level as is feasible. High-level circular economy strategies have been developed at national and state scales, while governments and brand owners have jointly established the National Packaging Targets, which include commitments to recycle 70% of Australia's plastic packaging by 2025 (up from 12% currently) and to ensure packaging contains 30% recycled content (on average).⁴³⁴ These strategies and targets are voluntary, but they may be effective as waste companies look for new outlets for recycled material.

Whether driven by strategy or the market, significant investment is likely to be required in new waste recovery and reprocessing infrastructure to meet the long-term needs of Australians. Such investment could also stimulate local economic activity through the creation of jobs, new products and tax revenue, while retaining valuable resources within the local economy and reducing reliance on virgin materials. Greater commercial focus on the development of waste markets could encourage greater innovation in the sector, complementing existing priorities of pollution control.

Reducing the impact of waste collection in the dense inner city

In 2013-14 Melbourne City Council commenced the trial operation of garbage compactors and recycling hub units for the collective use of businesses at two central city laneway locations. The chosen locations had been problem sites for the council due to local amenity impacts from existing bins crowding footpaths or overflowing with waste, leading to garbage being dumped informally. This was at odds with the aspiration to promote Melbourne's laneways as desirable urban precincts.

As at 2018, Melbourne CBD's centralised garbage compactors and recycling hubs have benefited local communities. Five laneway locations now

offer these facilities.⁴³⁵ For commercial users who would otherwise have to contract their own waste removal, the annual cost of using the hub ranges from \$920 to \$7,380 depending on volume.⁴³⁶

In addition to local amenity benefits, the centralisation of waste processing has been recognised as reducing pressure on the local road network in central Melbourne. In 2016, 36 different contractors were registered with council to operate in the CBD, meaning that servicing a single centralised compactor six times a week (at an annual cost of approximately \$150,000) could remove the need for up to 100 weekly vehicle movements.⁴³⁷



89. Opportunity

There is a lack of a mature market for private investment in recycling and waste disposal. There is a chance to capitalise on increased demand for recycled products and larger economies of scale as waste generation increases. Developing a domestic market could improve recycling rates and the sustainability of Australia's waste disposal.

When this will impact:



Where this will impact:



Major waste infrastructure is being developed outside our cities

Approximately half of Sydney's putrescible waste is now railed 250 km to the Woodlawn landfill outside Goulburn, while much construction and demolition waste is transported 900 km north to Queensland for cheaper disposal. Perth and Adelaide both use major landfills in regional sites around 100 km outside each city, while waste from south-east Melbourne is now hauled across that city to landfills on its north and western fringes, despite increasing urban density and congestion.

The high price of urban land and acute community sensitivity to waste facilities mean new waste infrastructure developments are often on the urban fringe or in regional locations. Landfill and large-scale processing facilities for mixed waste are more likely to be developed in regional areas. While this is subject to some community sensitivity, it can also create economic opportunities.

This trend will reconfigure the freight task. It will require transfer stations to aggregate waste for efficient bulk transport, either by road or rail.

Outside of cities, services are often inconsistent and not cost effective

The majority of Australians have access to kerbside waste collection and recycling services. However, 123 Australian local councils have no collection or recycling service at all.⁴³⁸ These areas are overwhelmingly in remote and regional parts of Australia. Regional and remote communities have limited access to recycling schemes and face logistical challenges like poor transport access, seasonal isolation and economies of scale. Large transport distances between regional and remote communities and end-markets also make the recovery of some waste types cost-prohibitive.

Many regional markets for recycled materials do not offer sufficient scale for infrastructure investment. However, coordinating waste collection and transport from several local councils could build enough volume to create the market conditions for recycling investment.

Transporting Sydney waste for alternative treatment

In 2018 Veolia commissioned the first alternative waste treatment facility for Sydney waste located in a regional area. The mechanical biological treatment plant at its Woodlawn waste precinct near Goulburn, New South Wales has a processing capacity of 144,000 tonnes per annum.⁴³⁹ Veolia runs two trains daily which carry 1,200 tonnes of putrescible household and commercial waste, destined either for the landfill or for the mechanical biological treatment plant. When the waste arrives, recyclables are mechanically separated and the remaining organic fraction is composted.

Another project in advanced planning is the delivery of waste-derived fuel from Sydney to the Mount Piper Power Station outside Lithgow, in the Blue Mountains. The waste-derived fuel, created from up to 200,000 tonnes per annum of waste, would be trucked to the power station, where it would power a specifically-designed boiler to boost the output of the existing coal-fired power station.⁴⁴⁰



90. Challenge

A lack of scale and access in remote communities means waste freight is inconsistent and not cost effective for consumers or taxpayers. As our waste generation increases waste services in these areas could become more expensive.

When this will impact:



Where this will impact:



Alternative fleets to reduce consumer costs and reduce noise

The repetitive stop-start of rubbish collection activities means that rubbish trucks are less fuel-efficient, more costly to run and more emissions and pollution-intensive than other heavy vehicles. There is significant interest in alternative fuel vehicles within the sector, including electric and compressed natural gas (CNG) options. Both are quieter than diesel versions; a key issue for residential areas when collection starts early in the morning.

CNG-heavy vehicles have been on the market for a decade and are becoming more widely available, including from mainstream truck brands. One of the specific synergies available from the use of such vehicles is the possibility of producing CNG from the methane that is generated when rubbish buried in landfill breaks down. Having ready access to this methane supply can offset the cost of cleaning and compressing it into useable CNG, with trucks simply refuelling after tipping a load at the landfill.

In the last few years, competing electric heavy vehicles have also emerged, ranging from small 3.5-tonne models through to a 15-tonne payload. The vehicles are well suited to stop-start collection, with instant torque and regenerative braking that improve energy efficiency and promise a range of up to 200 km. However, the extra weight of batteries needs to be traded off against the potential payload.

Heavy electric vehicles face other barriers to adoption. Problematically, Australian charging infrastructure is inappropriate for heavy vehicles that cannot charge in residential and service station settings. There are also issues with heavy electric vehicles' operation in flatter, less fuel-intensive geography. Melbourne's Moreland Council is taking a different route, converting its waste collection fleet to run on hydrogen.⁴⁴¹

Looking beyond fuel, waste collection may be well suited to autonomous vehicles, which can drive themselves from one wheelie-bin to the next along a pre-programmed route. In 2017, Volvo unveiled a demonstration model fitted with a sensor system designed to identify, navigate and monitor the vehicle's operating environment.⁴⁴²



91. Opportunity

Transporting waste can have high impacts on urban amenity. Using new technology could make waste transport more efficient and environmentally-friendly.

When this will impact:



Where this will impact:



5.15 Challenges and opportunities

Changing urban travel patterns

38. Challenge

Urban travel patterns are becoming increasingly complex, driven by economic, social, demographic and technological changes. There is a risk of growing divergence between the way our networks are planned and designed, and the needs of customers. Failure to cater for changing patterns of travel could contribute to growing congestion in our fast-growing cities.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



39. Challenge

Rapidly changing land use and development can place pressure on urban transport networks. Densification in our largest cities places pressure on legacy networks, while greenfield development requires new infrastructure and services. Failure to coordinate land use and transport planning can contribute to congestion and crowding in some areas, or a lack of adequate services in others.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



40. Challenge

Our radial public transport networks are inflexible and have varied levels of service and relatively low mode shares. Unless our public transport networks are designed to cater for a broader range of trips, they will not meet the changing needs of a growing number of customers.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



41. Opportunity

New technology and data sets are increasingly available in the transport sector, that can be used for planning and service delivery. Better information allows governments and operators to better understand and cater for customers' transport needs and expectations.

When this will impact:

0-5

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10-15

15+

Where this will impact:



42. Challenge

Australia has relatively low rates of active transport, driven by a range of issues including low densities and long distances, insufficient infrastructure and safety concerns. Without action, our transport networks and travel patterns will remain poorly integrated and sustainability improvements will be limited.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Technology and the future of passenger cars

43. Challenge

The accessibility and affordability of ride and carsharing could decrease demand for public transport. In these circumstances, demand shifts from space efficient public transport back to cars, potentially increasing congestion.

When this will impact:



Where this will impact:



44. Opportunity

Connected vehicles can reduce accidents, improve traffic flow and reduce costs for drivers. Leveraging this new technology could improve access, quality and cost outcomes for users.

When this will impact:



Where this will impact:



45. Challenge

Many regional, remote and rural communities do not have the economies of scale to justify private investment in charging infrastructure. Without charging infrastructure, users in these areas will have fewer opportunities for electric vehicle uptake.

When this will impact:



Where this will impact:



46. Challenge

There is a lack of appropriate regulation, trials and physical infrastructure to enable the use of many cooperative and autonomous vehicle features. Without action, the benefits offered by cooperative and autonomous vehicles will be missed.

When this will impact:



Where this will impact:



International, inter-state and inter-regional connectivity

47. Challenge

There is congestion on roads around our major airports, particularly in Sydney and Melbourne. Unless addressed, travelling to airports will become increasingly unreliable, leading to longer travel times.

When this will impact:



Where this will impact:



48. Challenge

Some of our major airports are subject to operational restrictions reducing airport efficiency however adding to local amenity. Without regular reviews to ensure regulation is fit for purpose, the efficiency of our airports could be unnecessarily compromised.

When this will impact:



Where this will impact:



49. Challenge

Governance and funding of our regional road networks is inconsistent and lack transparency. This means funding and maintenance is subject to budget volatility of different levels of government.

Without change to road network governance, our regional roads will continue to be poorly funded, maintained and safety may decline.

When this will impact:

0-5

5-10

10-15

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Where this will impact:



50. Challenge

Regional aviation often struggles to be financially viable and customers view it as costly. Without action, regional and remote communities will lack access to air services and affordable airfares.

When this will impact:

0-5

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Where this will impact:



51. Challenge

Our regional railways generally have uncompetitive travel times with cars and planes. This means they carry a relatively small share of passengers. Unless travel times are improved, regional rail will continue to play a small role, meaning regional customers have less choice when they choose to travel.

When this will impact:

0-5

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15+

Where this will impact:



52. Challenge

The popularity of cruise ships in Australia is growing, producing important tourism opportunities for fast-growing cities and regional centres. However, there is a lack of berths for international cruise ships, particularly in Sydney. Without additional berthing capacity, Australia will lose cruise ships and tourist visitation will decline.

When this will impact:

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Where this will impact:



Funding and maintaining our transport assets

53. Challenge

Asset maintenance lacks transparency, consistency and accountability. This is particularly the case for sectors that rely on government funding rather than user charges, such as roads and public transport.

Unless addressed, maintenance of our transport networks will become increasingly unsustainable.

When this will impact:

0-5

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Where this will impact:



54. Challenge

There is no clear link between expenditure on roads and usage, which means road expenditure is inequitable, inefficient, unsustainable and lacks transparency. Without reform, revenue from fuel excise will decline, drivers will not be charged fairly and people will be incentivised to drive, contributing to congestion.

When this will impact:

0-5

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Where this will impact:



55. Challenge

Public transport investments and operating subsidies are substantial, but decisions lack transparency. Unless addressed, public transport will continue to be subject to political cycles and budget conditions.

When this will impact:



Where this will impact:



56. Challenge

Regional and remote local governments struggle to fund and maintain roads and airports. Local governments often have relatively small revenue bases but are responsible for the maintenance of expensive transport networks. Without addressing funding shortfalls and maintenance practices, regional and remote infrastructure will become increasingly unsustainable.

When this will impact:



Where this will impact:



57. Opportunity

There are numerous emerging revenue sources for the transport sector, with many related to technological development and changing patterns of demand for transport. There is an opportunity for emerging revenue streams to improve the financial sustainability of our transport networks.

When this will impact:



Where this will impact:



Passenger transport sustainability and resilience

58. Challenge

Transport sector emissions are increasing. Passenger cars account for the vast majority of emissions, but heavy vehicles and aviation are projected to drive growth in emissions in the next 10 years. Without action, the emissions intensity of passenger transport may cause negative environmental impacts and Australia will fail to meet its emissions reduction targets.

When this will impact:



Where this will impact:



59. Challenge

Australian governments often do not incorporate sustainability or resilience into their final infrastructure projects. Without regular action, active and public transport modes will be underutilised and our infrastructure will be less resilient and sustainable.

When this will impact:



Where this will impact:



60. Opportunity

If partnered with low carbon intensity fuels hybrid electric, plug-in electric, hydrogen fuel cell and automated vehicles are less emissions intensive than internal combustion engine vehicles. These technologies can be leveraged to transition to a low-carbon transport sector. Reducing transport sector emissions would help Australia meet its international obligations while also improving local air quality.

When this will impact:



Where this will impact:



61. Challenge

Climate change is likely to cause increasingly frequent and severe weather events that damage transport assets. Without resilient infrastructure, network functionality could be limited and the costs of upgrades could be more substantial.

When this will impact:



Where this will impact:



Safety in the transport sector

62. Challenge

Road safety performance is not on track to meet the objectives of the National Road Safety Strategy. Without action road users will continue to be vulnerable and at risk of serious injury or fatality.

When this will impact:



Where this will impact:



63. Challenge

Project selection and funding is based on incomplete safety data. Without action, this will inhibit effective cost allocation and understanding of trade-offs with other transport outcomes, such as productivity.

When this will impact:



Where this will impact:



64. Opportunity

Regional, rural and remote road networks are less safe. There is an opportunity to focus investments and policies on these areas. Identifying, assessing and prioritising sites for upgrades and road treatments on high risk corridors could optimise investment and reduce fatalities.

When this will impact:



Where this will impact:



65. Challenge

Australians are holding on to their vehicles for longer. Older vehicles often do not meet modern safety standards and are more likely to injure or kill if involved in a crash.

When this will impact:



Where this will impact:



66. Challenge

Pedestrian and cyclist fatalities are over represented in fatalities and injuries. Without action, active transport users will continue to be injured and killed, and the attractiveness of active transport will remain low.

When this will impact:



Where this will impact:



67. Challenge

Technological change is driving the collection of valuable data by transport operators and network owners. This information is valuable and can be vulnerable to cyberattacks.

When this will impact:



Where this will impact:



Transport accessibility and equity

68. Challenge

Public transport service levels and access is lower in the outer suburbs and regional centres. This results in lower public transport mode share, and a reliance on cars in these areas. Without action, people who live in these areas will continue to be reliant on their cars.

When this will impact:



Where this will impact:



69. Challenge

People on the outskirts of our cities and in regional and remote Australia pay proportionally more for transport. Unless addressed, our transport networks will continue to be inequitable, with people in the outer suburbs and regional and remote Australia paying proportionally more.

When this will impact:



Where this will impact:



70. Challenge

There is insufficient funding to make our public transport networks accessible to people with disability. Unless funding shortfalls are addressed, legislated accessibility targets for public transport will not be reached and our networks will not be inclusive.

When this will impact:



Where this will impact:



71. Challenge

Emerging point-to-point operators are not subject to the same subsidy schemes and accessibility legislation as taxis, meaning they are not accessible to many people with disability. Without action, people with disability will not share in the benefits of emerging transport modes.

When this will impact:



Where this will impact:



Freight gateways supporting international trade

72. Opportunity

Growth in Asia and an increasingly globalised economy means the volume and value of Australia's trade is increasing. Enhancing, adapting and realigning freight networks will allow Australian producers to capitalise on opportunities presented by growing global markets, and Australian consumers to access imported goods as cheaply as possible.

When this will impact:



Where this will impact:



73. Challenge

Charges for truck and train operators accessing our major ports have increased and could be passed on to customers. It is challenging for governments to know if and when a regulatory response is required. Stevedores may have the ability to continue increasing charges, which may lead to growing costs for Australian exporters and consumers.

When this will impact:

0-5

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Where this will impact:



74. Challenge

Our major container ports are becoming more productive, but continue to lag behind our trading partners for key indicators. Our ports will need to continue to improve to ensure Australia is globally competitive. Without improvement, our ports will continue to be uncompetitive, potentially increasing the time taken to import and export goods and add to costs for Australian exporters and consumers.

When this will impact:

0-5

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Where this will impact:



75. Challenge

The need to balance passenger and freight services, operating restrictions and constraints on airport land and surrounding roads reduces the efficiency of our airports. The efficiency of our airports could decline further as demand grows, potentially leading to delays and higher costs for high value, time sensitive air freight and passengers.

When this will impact:

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Where this will impact:



The urban freight challenge

76. Challenge

Conflict between land uses, particularly in the inner areas of our fast-growing cities, decreases the efficiency of our urban supply chains, particularly warehousing. Conflicting demand for land is inevitable, and governments face a challenge in balancing the needs of different parties. Failure to address land use conflict will result in more operating restrictions on key facilities, inefficient layout of facilities, and additional freight trips on our transport networks.

When this will impact:

0-5

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15+

Where this will impact:



77. Challenge

Freight transport in our fast-growing cities is impacted by congestion leading to increased costs. If this is not addressed, delays in our urban supply chains will become more common and costs will increase as our cities grow.

When this will impact:

0-5

5-10

10-15

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Where this will impact:



78. Challenge

An increase in deliveries by light commercial vehicles is contributing to road and kerbside congestion, particularly in inner urban areas. This is driven by growth in online shopping and changing consumer expectations about timely and door-to-door deliveries. Without action, light commercial vehicles will make a growing contribution to congestion in major employment centres.

When this will impact:



Where this will impact:



Ensuring the national freight network is effective and efficient

79. Challenge

Inconsistent regulations, standards and technologies across our road and rail networks increase costs for transport operators and agricultural producers, which are ultimately passed on to customers. Without action, costs and time spent complying with regulation will remain unnecessarily high, reducing the productivity of our supply chains.

When this will impact:



Where this will impact:



80. Challenge

High productivity vehicle use is limited by community sentiment as well as physical and regulatory impediments to access to our road network. Restricted use of high productivity vehicles will lock in high freight costs for businesses and consumers, and limit benefits to road safety, air pollution and amenity.

When this will impact:



Where this will impact:



81. Challenge

The pace and impact of technological change on our supply chains is uncertain. Governments face dual challenges of enabling private sector innovation while also regulating to ensure change does not harm the community. If governments do not intervene appropriately, innovation could be stifled or, alternatively, technological development could pose safety and environmental threats.

When this will impact:



Where this will impact:



82. Opportunity

New technologies can help improve road safety and efficiency, but they have upfront costs that mean uptake rates remain low. Increased use of technology could improve road safety.

When this will impact:



Where this will impact:



Unlocking regional economic development through freight

83. Challenge

Remote and regional supply chains are critical for industry and to supply communities with basic needs. However, local governments often struggle to fund and maintain critical transport infrastructure. If this is not addressed, our agricultural supply chains and regional and remote communities will be vulnerable to delays, higher costs and extreme weather events.

When this will impact:



Where this will impact:



84. Challenge

The complexity of the freight sector means leveraging infrastructure investments to maximise regional development can be challenging. Without improved coordination between jurisdictions, infrastructure managers and freight operators, regional development opportunities will be missed.

When this will impact:



Where this will impact:



85. Challenge

Highly variable and seasonal traffic can make investment and maintenance of regional grain railways difficult to justify. This results in bottlenecks, speed restrictions, lower capacities and sometimes line closures. If this is not addressed, producers and transport operators will continue to incur higher costs and delays, particularly in high harvest years.

When this will impact:



Where this will impact:



Transporting, storing and making the most of our waste

86. Challenge

Australia has increasing waste generation, a lack of a mature market for private investment and a reliance on waste export. Without action, our disposal, recycling and transportation of waste will become more costly and environmentally damaging.

When this will impact:



Where this will impact:



87. Challenge

A limited number of new waste facilities and landfill sites have been approved and residential development is encroaching on existing sites. Without action, waste freight will have to transport their loads further from the waste generation point.

When this will impact:



Where this will impact:



88. Challenge

Waste is often transported large distances from where it is generated due to a patchwork of government regulation. Without action, waste will continue to be transported further from the waste generation point adding to congestion and road degradation.

When this will impact:



Where this will impact:



89. Opportunity

There is a lack of a mature market for private investment in recycling and waste disposal. There is a chance to capitalise on increased demand for recycled products and larger economies of scale as waste generation increases. Developing a domestic market could improve recycling rates and the sustainability of Australia's waste disposal.

When this will impact:



Where this will impact:



90. Challenge

A lack of scale and access in remote communities means waste freight is inconsistent and not cost effective for consumers or taxpayers. As our waste generation increases waste services in these areas could become more expensive.

When this will impact:



Where this will impact:



91. Opportunity

Transporting waste can have high impacts on urban amenity. Using new technology could make waste transport more efficient and environmentally-friendly.

When this will impact:



Where this will impact:



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6

Social infrastructure

Social infrastructure is comprised of the facilities, spaces, services and networks that support the quality of life and wellbeing of our communities. It helps us to be happy, safe and healthy, to learn, and to enjoy life. The network of social infrastructure contributes to social identity, inclusion and cohesion and is used by all Australians at some point in their lives, often on a daily basis. Access to high-quality, affordable social services has a direct impact on the social and economic wellbeing of all Australians.

This chapter represents a broadening of the scope of Infrastructure Australia's focus since the 2015 Audit. It responds to the growing recognition of the role effective social infrastructure assets and networks play in supporting our nation's wellbeing. It examines the challenges and opportunities Australians face in accessing affordable, high-quality infrastructure across six social sectors:

- Health and aged care
- Education
- Green, blue and recreation
- Arts and culture
- Social housing
- Justice and emergency services.

Social infrastructure assets are the buildings and spaces that facilitate the delivery of social services by governments and other service providers. While assets are often considered individually, our social infrastructure networks as a whole play a nationally significant role in supporting Australia's economy, liveability and sustainability.

Our growing and ageing population, increasing urbanisation, migration, advancements in technology, and the changing nature of work will impact this sector over the next 15 years and beyond. These trends will increase demand for social infrastructure, particularly in our cities, and change the expectations people have for the variety, quality and accessibility of social infrastructure services and assets.







6.1 Introduction



The state of the social infrastructure sector

Social infrastructure is an important part of our everyday lives – from local public swimming pools and childcare centres, to major hospitals, universities and art galleries.

Australia has high-performing social infrastructure sectors by international standards, as reflected in our ranking as the country with the third highest quality of life and standard of living in 2018.¹ However, ease of access to and quality of social infrastructure varies for different types of infrastructure, across different places and groups of people. For example, access to a major art gallery may be difficult for someone living in remote Queensland. In terms of quality,

our research shows that Australians rate social housing and health infrastructure as poor quality, while green and recreation, and arts and culture infrastructure are rated as being of good quality.²

Different social infrastructure sectors are also closely tied, and many people need multiple and overlapping services and facilities. This provides opportunities to align sectors to achieve better outcomes, but also makes the planning and management of social infrastructure more complex for service providers. Governments are increasingly recognising the need for better integration across social infrastructure sectors.



The scale of the social infrastructure sector

Compared to economic infrastructure, individual social infrastructure assets may be smaller in scale – a local public swimming pool, park or single social housing dwelling – however, together these assets form networks that deliver nationally significant benefits to the community, the economy and our environment.

On a national scale, social infrastructure sectors contributed 12.5% of Australia's GDP in 2018.³ These sectors employ just over 3 million people (or around a quarter of Australia's workforce).⁴ Australia has over 1,300 public and private hospitals,⁵ and over 9,400 schools.⁶ We make just over 100 million visits to public pools every year,⁷ and over 80% of us attended an art and cultural venue or event in 2018.⁸ There are close to 400,000 social housing dwellings across the country,⁹ and over 40,000 prisoners in over 100 prisons.¹⁰

Australia's social infrastructure performs well, but it can improve

Australia has high-performing social infrastructure sectors by international standards.¹¹ However, ease of access to and quality of social infrastructure varies for different types of social infrastructure, particularly for vulnerable groups, and in both fast-growing cities, and rural communities and remote areas.

While Australians rate the quality of our social services as high,¹² our infrastructure assets and networks are often ageing and not fit for purpose. This is particularly evident for sectors like education, where advances in technology are driving the need for more digitally-equipped and flexible spaces.



Social infrastructure assets are necessarily geographically dispersed to provide access to services for as many people as possible, but the type of infrastructure available varies for different places. Most towns have sports ovals and schools, regional centres also have hospitals and art galleries, while fast-growing cities have a full range of social infrastructure, and multiple assets. In areas where it costs more to deliver services per capita (such as rural communities or remote areas), or where space is constrained (in fast-growing cities), it may be difficult to access all types of social infrastructure. Delivering essential services such as primary health care and school infrastructure may be prioritised over other services, such as arts and culture or green infrastructure.

The cost of social infrastructure is highly subsidised by governments. People using a park, attending a public school or being treated in a public hospital are not directly paying the full cost of their use. This is because Australian society values the right to services like health care and education, regardless of ability to pay. However, costs to users can still be a significant (and sometimes unexpected) burden on household budgets. A high variation in cost to access some types of social infrastructure, such as recreation facilities, or arts and culture venues, can restrict access to these services for lower-income households.

Progress since the 2015 Australian Infrastructure Audit

Infrastructure Australia has expanded its focus to include social infrastructure as part of this Audit because social infrastructure plays a critical role in ensuring our society works effectively. Australia's population has grown by around 1.4 million people since the previous Audit in 2015.¹³ This rate of growth, coupled with technological advancements and an increasing expectation for personalised and transparent services, has changed the way social infrastructure is being delivered in Australia.

Australians feel that the quality of health and aged care has improved over the past four years, but affordability has decreased, particularly for older people.¹⁴ In the education sector, almost a quarter of Australians believe that quality has improved, while over a third have seen costs increase to participate in learning, particularly for those with or caring for someone with disability.¹⁵ Over a quarter of Australians say the quality and accessibility of our social housing infrastructure has declined over the past five years, while costs have increased. Perceptions of the quality of justice and corrections facilities have largely remained the same, while over a quarter of people feel the quality of parks and open spaces has increased.¹⁶ More than a quarter of Australians believe the quality of arts and cultural facilities have risen over the past five years.¹⁷

Over this period, social infrastructure has also become increasingly digital, helping to provide services to more people in a more personalised and up-to-date way. This is particularly evident in rural communities and remote areas, driven by the delivery of the nbn. Primary schools now have smartboards and online learning tools. A medical specialist in a capital city can consult with patients many kilometres away via telehealth services. A person in Western Australia can view items on display in the National Gallery of Australia in Canberra via digital collections. Library collections are also being digitised.



Social infrastructure is essential in making communities liveable

Social infrastructure is essential to maintaining and improving the quality of life of all Australians. It is critical for social inclusion and cohesion. Social infrastructure provides not only the essential services required for communities to function, but also the services that make places liveable and help improve the quality of life for people living there. Alongside economic infrastructure, it provides direct benefits to individuals, as well as broader social and economic benefits to local communities and Australian society as a whole.

However, experiences of social infrastructure can differ across the nation. Australians rate access to parks and open space more highly than telecommunications and public transport when choosing where to live.¹⁸ People ranked health and aged care services as the most important of all infrastructure sectors in which governments should invest more money.¹⁹

Communities in our fast-growing cities are witnessing rapid population growth, often without commensurate increases in social infrastructure and services needed to maintain liveability. Competition for space in growing and densifying cities can mean that other uses, such as commercial or residential buildings, are being delivered without sufficient access to social infrastructure, such as green space. The timely delivery of new and upgraded social infrastructure is integral to the success of Australia's cities as they grow. It can help to generate community buy-in for new development and re-establish trust in government institutions and services.

Social infrastructure is also critical to smaller cities and regional centres. Schools, sporting facilities, community centres and libraries often play central and multiple roles in these communities. This helps to build social cohesion and identity, and can help foster community resilience in times of stress, such as natural disasters. Social infrastructure assets like hospitals and universities can also act as economic anchors for these centres, providing a source of stable employment and supporting local economies.

Social policy and service delivery considerations drive social infrastructure decision making

Demand for social infrastructure is driven by social policy and service delivery requirements. These drivers impact infrastructure requirements and decision making for the planning, delivery, operation and maintenance of social infrastructure assets and networks. For example, hospitals may require more space for different types of technology to deliver improved healthcare outcomes, schools may require more flexible spaces to teach curricula which evolve alongside societal changes, and the size of prison populations may fluctuate depending on law and order policies and legislation.

Demand drivers for social infrastructure are not uniform across all sectors. While governments aim to provide easy and affordable access to high-quality social infrastructure for all Australians, they also manage demand for types of social infrastructure across different sectors. For example, government policy supports access to and regular use of green, blue and recreational infrastructure, arts and cultural infrastructure, and education. However, governments ration access to social housing infrastructure, and aim to minimise demand for others, such as ambulance services, hospitals and correctional facilities.

The proportion of total spending on social services that is allocated to capital expenditure (delivering, acquiring or maintaining physical assets) varies substantially across social infrastructure sectors. Capital expenditure makes up less than 5% of state and territory spending on education, and around one quarter of total spending on social housing.²⁰ However, in each social infrastructure sector, these assets play a critical role in delivering high-quality, accessible and affordable services for people.

There are significant relationships across social infrastructure sectors

Complex relationships exist across social infrastructure sectors that provide both challenges and opportunities for communities. For example, access to green and blue infrastructure can improve mental health outcomes. Health education and prevention programs in schools can improve community health outcomes from childhood, or conversely, poor health, education and housing outcomes can increase demand on justice infrastructure. Outside of social infrastructure, telecommunications infrastructure plays a key role in enabling digital social services such as telehealth, access to arts and culture infrastructure, or remote education and learning. Digital technology can also assist in capturing and sharing data for more informed decision making for the design, planning and delivery of social infrastructure. Coordinating social services with transport infrastructure is critical to quality of life and wellbeing.

Overcoming or leveraging the interrelationships between social infrastructure sectors can be a challenge for governments operating within sector-based structures. A lack of integration across portfolios can create disjointed social policy and infrastructure investment, and poor outcomes for communities who may receive high-quality access to certain services but not others.

However, some sectors leverage these relationships to improve benefits for communities. There are a growing number of health and education precincts across Australia, where hospitals and other medical facilities co-locate with universities and other research facilities to share resources and boost outcomes for both sectors. Proximity to hospitals can provide university students with practical work experience. Relationships have long been established between arts and cultural institutions and school curricula to enable better access to arts and culture for school children and improve wider learning and development outcomes.

There is also growing recognition that social services do not end at delivering a single asset. For example, realising the social and economic benefits of a hospital requires the physical buildings to be well integrated with transport infrastructure, so that people can access it. This requires health and transport sectors to collaborate. However, challenges remain in overcoming sector-based planning, funding and governance structures which limit the incentives for different infrastructure sectors to work together to improve benefits to communities.

In this chapter

6.2 Health and aged care focuses on the infrastructure needs of hospitals, aged care facilities and digital health systems. It analyses the substantial increases in demand for services and facilities as our population grows and ages. It also explores the challenge in providing high-quality health care in remote areas, and ensuring health infrastructure is fit for purpose for new models of care and technologies.

6.3 Education explores the changing population and technological demands being placed on education infrastructure, from early childhood through to tertiary and vocational levels. It shows that while urbanisation is placing pressure on urban schools, some regional areas are facing reduced class sizes and resources. At the same time, ageing buildings create challenges in providing modern, fit-for-purpose learning spaces for students. In the tertiary and vocational sector, campuses are often disconnected from other infrastructure, creating challenges for functionality and accessibility.

6.4 Green, blue and recreation explores the role of green spaces, waterways and community facilities in providing social, economic and environmental benefits to communities. It identifies fragmented governance as a key driver for unequal access, quality and cost of these spaces and facilities. In regional areas, sporting and community facilities often play a central role in social cohesion, while in urban areas, pressure is being placed on scarce land and there is a need to maintain natural spaces to help mitigate the urban heat island effect.

6.5 Arts and culture identifies the crucial role that arts and culture play in strengthening social inclusion and identity for Australian communities, and in delivering economic empowerment, particularly for Aboriginal and Torres Strait Islander communities. It describes challenges for the sector in providing fit-for-purpose spaces due to maintenance backlogs, heritage costs and storage constraints which can affect the quality and accessibility of cultural services.

6.6 Social housing analyses the challenges people face in accessing adequate and affordable housing, with a particular focus on social housing as an infrastructure class. It identifies a lack of social housing dwellings of the right type and in the right place, and explores the difficulty of transitioning between types of housing, particularly from social housing into the private market. It highlights the poor outcomes, particularly for health and education, that have resulted from overcrowding in remote areas due to a lack of fit-for-purpose dwellings and supply, with negative impacts for Aboriginal and Torres Strait islander communities.

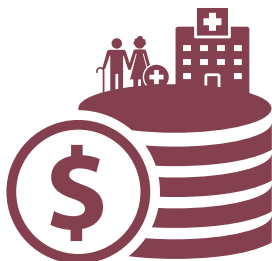
6.7 Justice and emergency services examines how advances in technology in the justice system and the changing nature of emergencies and disasters are both placing pressure on ageing, often not fit-for-purpose, infrastructure assets. It also shows that the ability of these sectors to adapt to change is often hindered by the complexity and interdependency of these sectors on others, such as health and social housing.

Performance of health and aged care infrastructure

Cost

1 in 2

people rate current health and aged care services as costly, and predict costs to rise ²¹



Access

110 full time GPs per

10,000

people in major cities, but **only half as many** in very remote areas ²²



Quality

Average length

of a mental health hospitalisation is

17 days ²³



Quality

Health services are rated as poor by

one in five people ²⁴



Quality

Death rates of people living in very remote areas are

2.5 times higher

than those living in major cities ²⁵

Access



26 public hospital beds

for every 10,000 people ²⁶

Cost



Government spending on health grew to

\$124 billion

in 2016-17 ²⁷

Access

People living in remote areas accessed Medicare-subsidised mental health services at a rate of

three times less

than people living in major cities ²⁸

Scale of health and aged care infrastructure

Industry



Australian government's real health expenditure per person is projected to **more than double** over the next 40 years ²⁹

Customer

63% of adults, and **28%** of children are overweight or obese ³⁰



Asset

Nearly half of Australian hospitals are **private** ³¹



Customer

Half of Australians have a chronic condition



1 in 4 people have two or more chronic conditions ³²



Almost **70%** of health spending was funded by governments

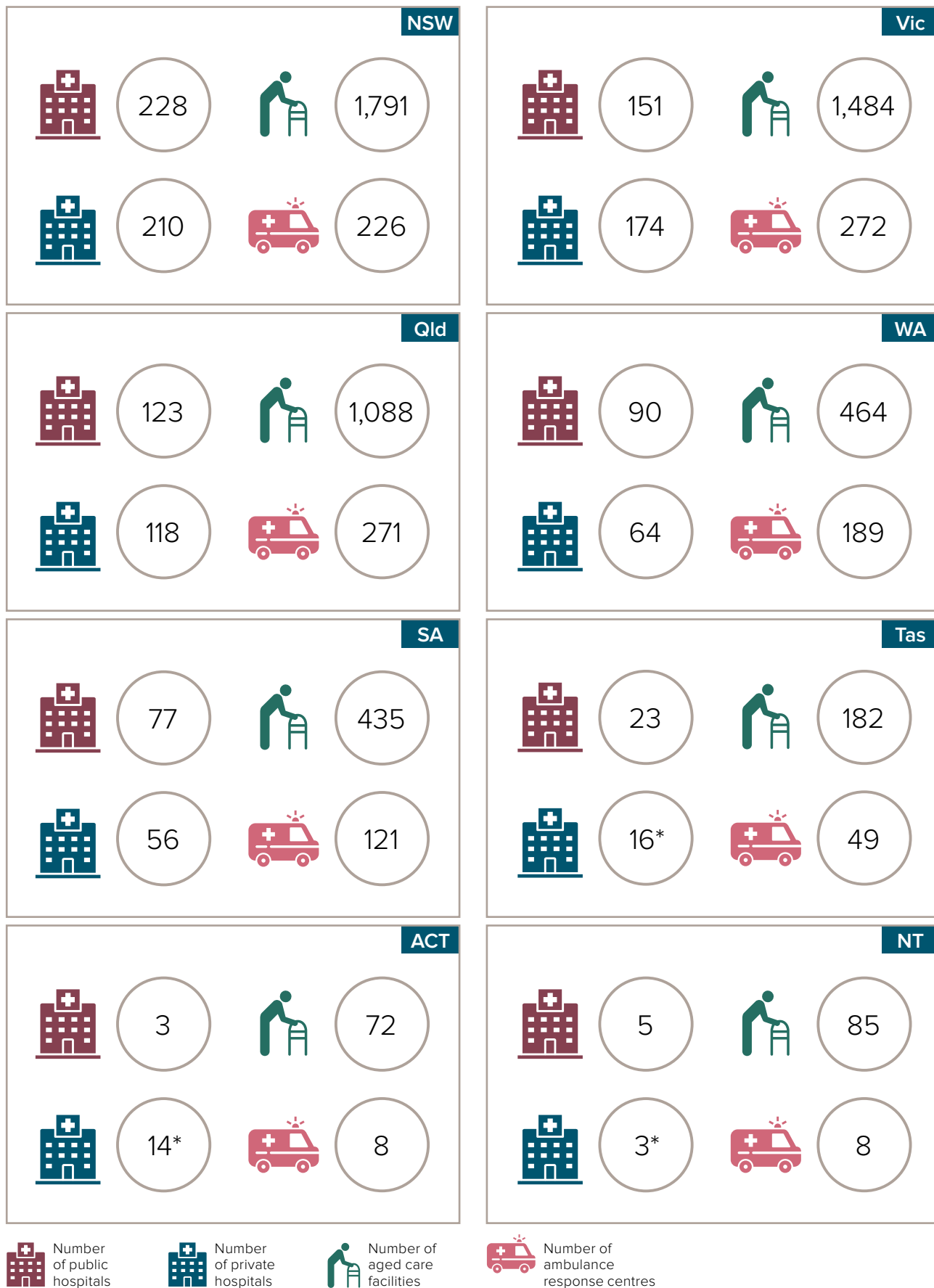


Less than **10%** was funded through private health insurance ³³



Industry

Scale – by state and territory



Notes: ABS does not provide the public/private split of hospitals for Tasmania, the Australian Capital Territory, or the Northern Territory. Alternative private hospital data for these states and territories have been sourced from the Department of Health website.

Source: Based on EY analysis for Infrastructure Australia and supplementary engagement with relevant jurisdictions.

6.2 Health and aged care

Sector overview

Health and aged care infrastructure promotes, restores and maintains a healthy society. It is delivered by a variety of public and private providers in a range of settings, and includes illness prevention, health promotion, the detection and treatment of illness, rehabilitation and end-of-life care.³⁴ Key services include:

- **Primary care:** Care provided to patients not admitted to hospital. Typically a person's first contact with the health system, general practice is the cornerstone of primary care. Primary care can also be provided in the home and community by nurses, allied health professionals, midwives, pharmacists, dentists and Aboriginal health workers.
- **Acute care:** Care provided to patients admitted to hospital that is intended to cure illness, alleviate symptoms of illness or manage childbirth.
- **Residential aged care:** Care and services delivered to older people in Australia by providers approved under the *Aged Care Act 1997*.
- **End-of-life (palliative) care:** Care aimed to improve the quality of life for patients with an active, progressive disease who have no prospect of cure.
- **Telehealth:** Healthcare delivery when some of the participants are separated by distance and information and communication technologies are used to overcome that distance.
- **Public health:** Activities aimed at benefiting a population, with an emphasis on prevention, protection and health promotion, distinct from treatment tailored to individuals with symptoms.

This Audit focuses on the infrastructure needs of hospitals, aged care facilities and digital health systems, (with emergency health services infrastructure, such as ambulance stations, considered in Section 6.7). However, it is important to acknowledge the critical and interconnected role the primary health network plays in reducing demand on hospitals and acute health services.

At a glance

Our growing and ageing population puts greater pressure on and increases the costs of health and aged care infrastructure.

This section explores new healthcare models that can help reduce demand on our hospitals. It looks at the challenges facing our aged and disability care sectors, which are not responding to user needs and changing preferences. It identifies shortcomings in rural and remote healthcare.

This section also identifies opportunities to improve care standards with new technology, as well as to better coordinate health infrastructure with other facilities, such as research and transport.

Demand for health and aged care infrastructure is increasing

While Australia is regarded as one of the healthiest nations in the world, with one of the best universal healthcare systems, our health infrastructure faces challenges due to its scale, age, complexity and fragmented nature.³⁵ There are also significant governance challenges as responsibility for policy development, funding and service delivery lies across all levels of government.

The healthcare needs of an increasing number of Australians are an important social and economic challenge facing Australia. As Australia's population grows and ages, and as the prevalence of chronic disease increases, the demand for health infrastructure increases. The location of this demand is overwhelmingly urban, with over 95% of our population growth occurring in major cities and inner regional areas over the past decade.³⁶ Supporting the health of Australians not only improves individual people's lives but also helps to boost Australia's economic productivity and social wellbeing.

In 2015-16, there were more Australians aged 45 or older than under 30 for the first time since Federation.³⁷ In 20 years, around 20% of Australia's population will be aged 65 or over.³⁸ The number and proportion of older Australians is expected to generate increasing and more complex demand for health and aged care services.³⁹ Projections indicate Australia could have a lack of residential aged care beds to support this demand, in the order of almost 100,000 by 2025.⁴⁰

Rising life expectancy and changing lifestyles has meant that chronic diseases are becoming increasingly

common. Half of Australians today have at least one common chronic condition, such as cancer, cardiovascular disease, a mental health condition, arthritis, back pain, diabetes, lung disease or asthma.⁴¹ As people age, the prevalence and multiplicity of these conditions increase. The treatment of chronic diseases is placing more pressure on the cost of care and associated infrastructure, with 39% of preventable hospitalisations due to chronic diseases.⁴² This in turn contributes to reduced service quality from bed shortages and potential delays to accessing acute care.

92. Challenge

Demand for health and aged care services and infrastructure is increasing due to our growing and ageing population, and rising incidence of chronic diseases. This is placing pressure on already stretched health infrastructure. Without action, our healthcare system will be unable to meet this demand and maintain quality, accessibility and affordability of services for communities.

**When this
will impact:**

0-5

5-10

10-15

15+

**Where this
will impact:**



The cost of health and aged care infrastructure is rising

Constrained government revenue (and competing spending priorities) along with increased demands on the health system are creating cost pressures across the sector.⁴³ However, community research shows that, when looking to the future, health and aged care infrastructure is the top investment priority for Australians, above other types of infrastructure investment.⁴⁴

The total national spend on health goods and services was \$180.7 billion in 2016-17 – approximately \$8.1 billion more in real terms than in 2015-16.⁴⁵ Health expenditure is currently growing faster than GDP growth. Within this total spend, government expenditure on health grew by 6.8% in real terms to \$124 billion in 2016-17, notably higher than the average growth rate for the previous five years of 2.6%.⁴⁶

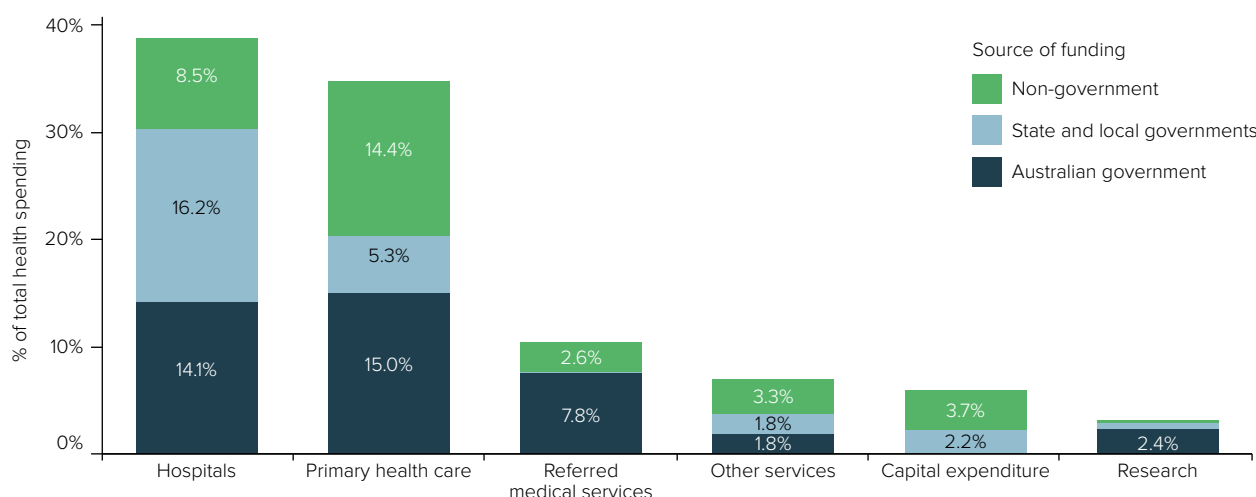
While capital investment in health infrastructure represented just under 6% of Australia's total health expenditure in 2016-17,⁴⁷ further investment in infrastructure, including for repair, maintenance and upgrades, will be required to support this significant growth in demand. This is reflected in government expenditure priorities, where capital expenditure increased at a faster rate than recurrent expenditure (operations and services) between 2006-07 and 2016-17.⁴⁸

The Australian Treasury's 2015 Intergenerational Report noted that, without intervention, Australian governments will need to double spending on health care per person by 2054–55 in order to maintain current service levels.⁴⁹ Non-demographic factors such as higher incomes, chronic diseases and technological changes are the largest contributors to growth in real, per-person health spending.

From a user perspective, around 50% of Australians consider health and aged care to be costly.⁵⁰ Individuals spent \$29.8 billion on health-related expenses in 2016-17,⁵¹ and healthcare costs as a proportion of household income rose by over one quarter for Australian households between 2009-10 and 2015-16.⁵² However, these costs are primarily focused on primary and allied health care (including 70% for primary health care and almost 20% for dental services), rather than infrastructure costs.⁵³

As Figure 1 shows, hospitals (39%) and primary health care (35%) accounted for around three quarters of all government health spending in 2015-16.⁵⁴ The type of health infrastructure that governments invest in is expected to change over the next 15 years, as expenditure is increasingly focused on health IT and community health services.⁵⁵ Telehealth services that provide mobile health, teleconsultation and medical and health education over a distance can also drive efficiency and lower expenditure for other health services.⁵⁶

Figure 1: Hospitals and primary health care account for around three-quarters of all health spending in 2015-16



Note: Hospitals includes public and private services. Primary health care includes un-referred medical services, dental services, other health practitioners, community health and other, public health, benefit-paid pharmaceuticals, all other medications. Referred medical services refers to non-hospital medical services that are not classified as primary health care. Other services includes patient transport services, aids and appliances, and administration.

Source: Australian Institute of Health and Welfare (2018)⁵⁷

Despite increased expenditure, health infrastructure still faces lags across Australia in providing fit-for-purpose facilities for modern health care. In particular, maintenance backlogs are substantial and growing, as a result of ageing hospital assets and competing priorities for expenditure, and a focus on service delivery over asset maintenance. For example, the Queensland Audit Office estimated the state's maintenance backlog in 2017-18 at \$600 million, an increase of \$276 million since 2012 despite the delivery of a remediation program over that period.⁵⁸ In New South Wales, the Auditor-General found that maintenance expenses made up 2.8% (\$621 million) of total expenses for NSW Health in 2017-18, and that maintenance backlogs and high levels of unplanned maintenance occurred in selected health entities reviewed.⁵⁹

New healthcare models can help to reduce demand on hospital infrastructure

Australia has more than 1,300 public and private hospitals that provide about 30 million days of admitted patient care each year, including both same-day and overnight admissions.⁶⁰ Our emergency departments receive more than 20,000 presentations each day.⁶¹

The total number of hospitals in Australia has not grown steadily over time, having reduced between 2012-2013 and 2016-17 by 13. Over this period, the number of public hospitals reduced by 51 and this is largely attributed to changes in reporting from states and amalgamation of hospital infrastructure.⁶² Over the same period, the number of private hospitals grew by 38.⁶³

93. Challenge

The changing nature of health issues are driving up the cost of health infrastructure and services for both governments and users. If not addressed, government funding will become unsustainable and costs will become unaffordable for people, particularly those on lower incomes.

When this will impact:



Where this will impact:



Despite larger public hospitals and a growing number of private hospitals, growth in total hospital beds across Australia (1.2% per annum) is not keeping pace with population growth (around 1.6% per annum). State and territory governments will not be able to provide hospital beds or points of care at the same ratio per head of population that they have in the past.⁶⁴ Maintaining the current ratio of 3.9 hospital beds per 1,000 people into the future will continue to be a challenge, requiring an estimated additional 18 hospitals to be built per year by 2040.⁶⁵

The role of hospitals in the health system will therefore need to adapt to meet growing demand. The current healthcare system cannot be scaled up to physically meet growing demand, meaning alternative approaches, such as new models of care, health prevention and wellbeing, will be required.⁶⁶ However, even with adaptation and new models of care, new infrastructure will still be required, including hospitals, primary care and community health facilities.

Despite the high cost to governments, clinical care only accounts for 20% of the factors influencing an individual's length and quality of life.⁶⁷ Focusing on the remaining 80% – healthy behaviours, social and economic support, and a physical environment which promotes health outcomes – is critical.⁶⁸ Two key approaches provide opportunities to reduce the demand on hospital infrastructure – preventive health policies and investment, and out-of-hospital care.

The rise in chronic diseases in Australia means that preventive care is a crucial part of reducing demand on health infrastructure, particularly hospitals. Australia's expenditure on preventive health is low compared to other OECD countries, at around 1.5% of total health expenditure.⁶⁹ The CSIRO proposes that future investments in the health system will likely shift from illness treatment towards health and wellbeing management, which could provide a more cost-effective, non-infrastructure solution to addressing increased demand for healthcare services.⁷⁰ Australia is already making this shift in some areas, for example by adopting the Otago program from New Zealand, which reduces hospitalisations for older people resulting from falls,

by encouraging program participants to do exercises to increase muscle strength and balance to prevent falls from happening.⁷¹ It is estimated this approach reduces fall rates (and therefore demand on hospital and ambulance infrastructure) for participants by one third.⁷²

Preventive health care and initiatives to keep people healthy and out of hospital can also be considered alongside investment in infrastructure that supports physical activity, including active transport and green infrastructure.⁷³ Providing supportive infrastructure for healthy lifestyles can help to reduce the number of people who are overweight or obese, and the incidence of other lifestyle diseases. Currently almost two thirds of Australian adults are considered overweight or obese.⁷⁴ The influence of the built environment in promoting healthy behaviour is increasingly being understood. Factors in the built environment, such as walkability and street safety, access to high-quality and useful green space, and proximity to fresh, healthy food, can help to reduce incidence of obesity.⁷⁵

Out-of-hospital care – whether at home or at other facilities, such as aged or end-of-life care centres, and primary or community healthcare facilities – offers another way to reduce demand on hospital infrastructure. While this approach is not new, it could have a significant impact on taking pressure off hospitals as our population grows and ages into the future. In particular, it could help to prevent unnecessary hospitalisations, which accounted for over 9% of hospital bed days across Australia in 2015-16.⁷⁶

Enabling out-of-hospital care not only relies on ensuring alternative healthcare services are accessible, affordable and high quality, but also on communities knowing they exist and how to access them. One method for raising awareness is by promoting education programs that explain what alternative healthcare services and facilities are available, and the importance of seeking care early. This can allow people to avoid exacerbated health issues, and reduce undue stress on hospital infrastructure by reducing unnecessary Emergency Department visits.⁷⁷

94. Opportunity

New healthcare service models that improve in-home and preventive care can reduce hospitalisations. Embracing new models can alleviate pressure on hospital infrastructure, improving access and service quality for those who need it most.

When this will impact:



Where this will impact:



Aged care infrastructure is not yet responding to changing preferences

Governments are involved in a number of aspects of caring for and supporting older Australians. These include organising and subsidising care and support services, supporting the provision of aged care infrastructure and aiding carers.⁷⁸

There is an increasing preference for older Australians to age in their homes and communities. Social connectedness is a key determinant of health, with older people living in residential care reporting feeling lonelier than those living in the community.⁷⁹ There is also increasing community concern about the treatment of older people in residential aged care facilities. The Royal Commission into the Aged Care Quality and Safety was established in October 2018.⁸⁰

At-home aged care can utilise existing spaces to better meet older people's individual needs, and increasingly digital services such as telehealth can provide care to more remote areas, including at home. This can in turn help to reduce the demand on larger health infrastructure by decreasing the need for expensive patient transfers and hospitalisations.

The Productivity Commission contends that people are often transferred back and forth between hospitals and aged care facilities, as aged care facilities lack high-level medical or end-of-life care expertise and qualified staff to administer care. New investments to expand community-based end-of-life care services, and improve access to specialist end-of-life care support in aged care facilities, would help to reduce the rate of hospitalisations. They may also limit the associated emotional and financial costs for older Australians and their families.

Investing in at-home care can also help to increase the average age that an older person reaches before needing residential aged care by as much as 10 years, to 82 years old. This can have substantial impacts on the number of aged care beds and length of care required in residential care and can reduce associated infrastructure costs.⁸¹

Catering to the preference for people to age in their communities will require greater provision of and access to home care, greater breadth of services

(including meal services and financial management support), more adaptable homes and a diversity of housing types and public spaces that cater for older people and people with disability.

However, the need for residential aged care facilities and services will still exist for those unable to remain in their homes. Additional infrastructure will be required to accommodate a growing population and proportion of older people. Facilities may also require upgrades to provide appropriate care for specific conditions, such as dementia care. There are opportunities to increase co-location, which is already occurring, where a variety of services, such as retirement living with residential aged care and healthcare facilities, are located together to leverage shared resources and provide a continuum of care.

In rural communities and remote areas, easily accessible and fit-for-purpose aged care infrastructure and services areas can enable older Australians to stay in the communities they love, and avoid unnecessary hospitalisations or moving away from home. However, providing these services to support a wide range of communities is a challenge. The Royal Flying Doctor Service has found that the absence of aged care services in remote areas correlates with an increase in transfers by air of older remote residents for preventable hospital stays.⁸²

Additionally, limited infrastructure in rural communities and remote areas can be required to service overlapping needs. Where respite centres and end-of-life care facilities in rural communities and remote areas are available, such as Tennant Creek and Alice Springs, they are often at capacity because they provide services for a wide range of people (including younger people with disabilities or terminal illnesses) and therefore may not be accessible to older people.⁸³

Demand for end-of-life care is growing rapidly as more people enter the older age groups in which most deaths occur. As this demand increases, more people are being cared for and die in a place that does not fully reflect their choices. The use of end-of-life care services in hospitals has been rising at a faster rate than other hospitalisations – increasing by 28% from 2011-12 to 2015-16, compared with 15% for total hospitalisations.

95. Challenge

Chronic condition, aged and end-of-life care infrastructure is not responding sufficiently to changing preferences for care at home or in community. Without action, this care will not be accessible, dignified, nor person centred for a growing number of Australians.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Infrastructure solutions for disability care are not always fit for purpose

There is a lack of appropriate disability residential care infrastructure in Australia. People with a disability requiring residential care (generally because of a need for complex health care), regardless of age, are often presented with limited choices that are not appropriate for their needs.⁸⁴ This can result in younger people with disability living in aged care facilities or acute mental health facilities.

The Department of Health estimated that there were 5,905 people aged under 65 years of age living in residential aged care facilities across Australia as at September 2018, and of these 188 were aged under 45 years of age.⁸⁵ These facilities are not built for young people, with many young people entering these facilities experiencing social isolation and reduced independence. Only around 10-15% of these people who move out of aged care move into more suitable alternative homes.⁸⁶

The National Disability Insurance Scheme (NDIS) has the potential to offer young people different options

other than living in an aged care residential facility. As at 31 December 2018, there were almost 2,600 Specialist Disability Accommodation (SDA) properties under use in the NDIS, and close to 11,000 NDIS participants with SDA supports in their plans.⁸⁷ An estimated 28,000 participants will require SDA when the NDIS is fully rolled out.⁸⁸

Data can assist with the design of policy, programs and procurement to assist younger people with disability to transition out of residential aged care. However, there is no current data available on the number of NDIS participants leaving residential aged care to live in the community. Both the Royal Commission into Aged Care Quality and Safety,⁸⁹ and the more recent Royal Commission into Violence, Abuse, Neglect and Exploitation of People with Disability,⁹⁰ will consider how to best deliver high-quality and affordable services to people with disability, including younger people in residential aged care facilities. Findings from these inquiries could unlock beneficial reforms in the sector, improving the quality, accessibility and cost of necessary infrastructure for people with disabilities.

96. Challenge

Young people with disability are often forced to live in inadequate or not fit-for-purpose facilities, including aged care and mental health facilities, due to a lack of purpose-built facilities for people with disability. If not addressed, young people with disabilities will continue to experience poor-quality care that does not meet their needs, and reduces their quality of life.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Providing high-quality health care to rural communities and remote areas is a challenge

Around 29% of Australians, or 7 million people, live in rural communities and remote areas. Populations in many of these areas are stabilising or declining, making it difficult for governments to provide a large range of services. Adequate access to health services and specialised health care can therefore be challenging in these areas.⁹¹ This is coupled with high rates of disease, traumatic injury and potentially avoidable deaths in remote areas of Australia.⁹²

Rural communities and remote areas also have limited access to specialists, primary care professionals (such as GPs) and other health practitioners, as well as reduced access to acute care infrastructure.⁹³ The Royal Flying Doctor Service reports that remote regions, where fewer than 60% of the population can access a hospital service within a 60 minute drive,

are concentrated in Northern Australia (including West Arnhem, Katherine, Barkly, East Pilbara, Bowen Basin–North, Outback–North and East, Central Highlands in Queensland, and East Arnhem) and south Western Australia (including Albany and Goldfields).⁹⁴ While there are higher numbers of public hospital beds per 1,000 people in remote and very remote areas compared with fast-growing cities, the key challenge is accessing these services when acute care is required.⁹⁵

In particular, there is a strong correlation between geographical isolation and reduced access to mental health services. People living in remote and very remote areas accessed Medicare-subsidised mental health services at a rate of three to six times less than people living in fast-growing cities in 2016-17.⁹⁶ This reduced access to mental health services is one of many drivers reflected in the higher rate of suicide in these areas. In 2016, 47% of suicides occurred outside capital cities, despite these areas accounting

for only 32% of Australia's population.⁹⁷ The overall high rate of suicide is influenced in part by very high suicide rates for Aboriginal and Torres Strait Island people within these locations. A modern healthcare system must respond to areas of growing need and changes in technology, which is particularly relevant within rural communities and remote areas. Telehealth can help address this inequity in access. Most importantly however, the community must be involved in the service design and delivery of mental health care.

Healthcare information sharing plays an important role in overcoming challenges of remoteness. Ensuring continuity and integration of care enables earlier discharges from hospital and reduces the need for unplanned re-admissions. Providing integrated and continuous care relies on appropriate

sharing of clinical information between hospitals, specialists and primary healthcare providers such as GPs.⁹⁸ For people in rural communities and remote areas, efficient information sharing can be vital, as their health services may sit across multiple health districts, or even state and territory borders.

It can also be challenging for people living in rural communities and remote areas to access the full range of services they require. A person may need to visit two specialists who are located in two different centres, adding to the cost and time required to access these services. Clustering of medical facilities and specialist services does occur in some regional centres, and can improve the quality of care for rural and remote people, particularly when enhanced with adequate transport and telecommunication networks.

Health outcomes are poor for Aboriginal and Torres Strait Islander communities in rural communities and remote areas

More than a decade ago, the Council of Australian Governments committed to closing the gap in life expectancy between Aboriginal and Torres Strait Islander peoples and other Australians by 2031, and halving the gap in child mortality rates by 2018. Progress towards achieving these targets is not on track.⁹⁹

While rural and remote Aboriginal and Torres Strait Islander communities face the same challenges as other rural and remote communities in accessing good-quality, affordable health infrastructure, their health outcomes are poorer. Life expectancy estimates for Aboriginal and Torres Strait Islander peoples reduce with increasing remoteness, while life expectancy estimates for other Australians are similar between urban and remote areas.¹⁰⁰ In remote and very remote areas, Aboriginal and Torres Strait Islander life expectancy is 13.9 years lower than for other Australians.¹⁰¹ This inequality has significant impacts on the social, cultural, economic and physical and emotional wellbeing of Aboriginal and Torres Strait Islander peoples.¹⁰²

Healthy lives rely on multi-sectoral approaches to health care. Addressing healthcare service and access needs through infrastructure, health promotion and policy simultaneously supports health outcomes. For example, housing is a key social determinant of health, with demonstrated links between the quality and location of housing, and health and wellbeing outcomes.¹⁰³ High-quality, well-maintained health-related hardware, such as taps, toilets, showers and sinks, are basic facilities considered important components of a healthy living environment. In 2012-13, 35% of Aboriginal and Torres Strait Islander people reported living in a dwelling with one or more major structural problems.¹⁰⁴ Overcrowding in housing can also lead to adverse health outcomes, with families living in overcrowded circumstances more susceptible to contracting infections through lack of hygiene and close contact with others.¹⁰⁵ Overcrowding has also been identified as a risk factor of exacerbating family violence and mental health issues.¹⁰⁶

97. Challenge

Low service densities can limit the provision of accessible, continuous and quality health care in rural communities and remote areas. Without action, healthcare outcomes for communities in these areas, particularly Aboriginal and Torres Strait Islander peoples, will continue to be adversely affected.

When this will impact:



Where this will impact:



New technologies are providing opportunities to improve health and aged care

Advances in technology have already transformed the delivery of health care and the patient experience.¹⁰⁷ Digital health services use technology to collect and share health information, improving the quality, cost and accessibility of health services and infrastructure. Technology-enabled out-of-hospital healthcare models include community, home-based and virtual care.¹⁰⁸ Examples of this include a patient wearing a device to record physical activity each day, or healthcare providers sharing clinical notes electronically to ensure quality of care is maintained across service locations.

Digital health care can improve the efficiency and quality of health care, with the potential to reduce time and distance barriers, particularly improving access for people in areas where physical health infrastructure is not economically viable. Advanced diagnostic technology, and the ability to connect with specialists can enable early healthcare interventions and contribute to saving lives. However, the type of health care required can determine the need for travel or not. For example, an urgent once-in-a-lifetime life-saving operation will likely require immediate travel for high-level specialist care, whereas a weekly service such as dialysis could be provided in smaller local facilities, closer to home.

CSIRO note that connectivity and telecommunication infrastructure challenges in remote communities and areas may pose barriers to a more integrated and data-enabled health system.¹⁰⁹ However, there is

evidence that the community is prepared to embrace new approaches, with one in four people considering themselves likely to use telehealth services within the next five years.¹¹⁰

As clinician and consumer preferences for technology-enabled health infrastructure rise, governments will need to prioritise greater spending on equipment, and supporting upgrades to buildings and spaces within hospitals and aged care facilities. When Magnetic Resonance Imaging was first listed in 1998, there were 38 machines operating in Australia.¹¹¹ As at September 2017, there were 348 Medicare-licensed machines in operation.¹¹²

For individuals, technology can help people to track and control their own health information and make informed decisions.¹¹³ For healthcare providers, new technologies can support continuity of care, improving interactions between providers and patients, and the effectiveness, efficiency and delivery of services. However, real concerns exist around privacy and security of sensitive health data.

Government has a clear role in ensuring digital technology is implemented and used efficiently, for the benefit of patients. Digital infrastructure, particularly information sharing systems, also require robust security and privacy measures to ensure personal and confidential information is kept safe and used appropriately. Adequate data storage, consistency across systems (such as between public and private hospitals, or between acute and primary healthcare practitioners) and increased energy needs for digital infrastructure may pose challenges as these systems expand in use and complexity.

Parkville Electronic Medical Record Program

Three health services located in the Parkville precinct of Melbourne (the Peter MacCallum Cancer Centre, The Royal Women's Hospital and Melbourne Health) are building a fully integrated Electronic Medical Record (EMR). This single clinical and research EMR will support integrated care delivery and provide specialist functionality for intensive care units, operating theatres, maternity and oncology. Clinicians will be able to securely access real-time patient information from any of the three health services.¹¹⁴

98. Opportunity

Technological advancements are enabling health infrastructure to be more digitally-oriented, from patient care to record keeping and infrastructure management. Embracing new technologies has the potential to reduce time and distance barriers to accessing health care, and improve efficiencies and quality of care.

When this will impact:



Where this will impact:



Health infrastructure precincts can capitalise on relationships between sectors

A precinct approach to health infrastructure can improve the efficiency and quality of care while supporting other health services such as allied health and private practice, and other infrastructure sectors, for example by partnering with universities, research centres and transport operators. Health precincts can also operate as anchors for local economies, particularly in smaller cities and regional centres where health services may be the largest employer.

These locational arrangements can also share resources, such as physical spaces and buildings, advanced technologies and equipment, hospitality, retail and other facilities and services such as waste management or high-speed internet. Integrated health precincts are more likely to attract global expertise and talent and will also benefit from locating in areas where affordable accommodation is available for staff. Co-location within precincts can also encourage greater levels of innovation within and across sectors.

In particular, regional centres can benefit from a precinct approach by combining health and research functions and focusing on specialisations. Tamworth Health Precinct, which will incorporate the University of Newcastle's Rural Health Multidisciplinary Training program, is an example. In this case, ongoing investment has included a redeveloped hospital and new cancer centre that have attracted people to relocate and helped to attract and retain specialists. This has acted as an enabler for regional economic development, with healthcare employment increasing by a total of 354 jobs between 2011 and 2016.¹¹⁵

Westmead Health and Education Precinct

The 75-hectare Westmead precinct comprises over 400,000m² of high-end health-related developments, including four major hospitals, three world-leading medical research institutes, two university campuses and the largest research-intensive pathology service in New South Wales.

The convergence of different sectors and specialisations creates opportunities for new projects, technologies and market solutions that build on an established ecosystem of leading public and private health, education and medical research anchor institutions to attract further health-related investment.

More than \$3 billion has been committed by government, universities and the private sector to upgrade and expand the precinct's health services, education and medical research facilities over the coming years. By 2036, the number of full-time staff working in the precinct is expected to be more than 30,000 and the number of students will expand to more than 10,000.¹¹⁶

99. Opportunity

The delivery of new and upgraded major health infrastructure in cities provides the opportunity to co-locate these assets with other services, such as other health services, research, education and community infrastructure. Creating health precincts could enable more integrated health care, with higher quality and greater accessibility for patients, and improve Australia's health research and education capabilities, attracting global expertise.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Performance of education infrastructure

Cost

Average weekly
cost of childcare
rose by almost

50%

between 2011 and 2017 ¹¹⁷



Quality



Almost half of Victoria's school buildings are over ¹¹⁸

25 years old

Access

68%

of all children aged 0-5 are enrolled in the **National Quality Framework** ¹¹⁹



Quality

85%
of students

rate university
learning and student
spaces as good or
excellent in 2017 ¹²⁰

Cost

Total government spending
on education was just over

\$73 billion

in 2018 ¹²¹

Access

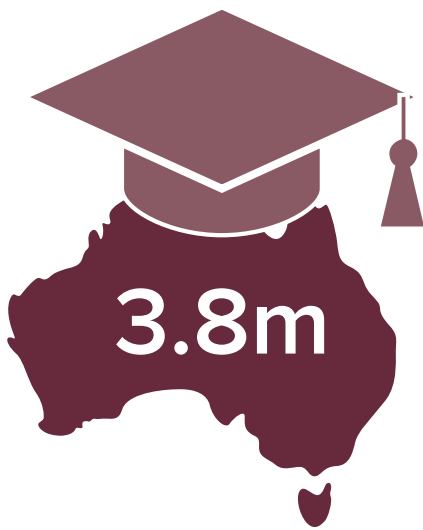
**Only
27%**

of early childhood education
services are available during
non-standard hours ¹²²



Scale of education infrastructure

Customer



3.8m

students enrolled in

9,444 schools

across Australia ¹²³

Industry



International education

is Australia's largest service export, contributing

\$28b ¹²⁴

Industry

65%

of students attend public schools

35%

of students attend private schools ¹²⁵



Asset



37 Australian public universities have:

a gross floor area of **11 million square meters**,
usable floor area of **7.2 million square meters**,
with a replacement value of **\$45 billion** ¹²⁶

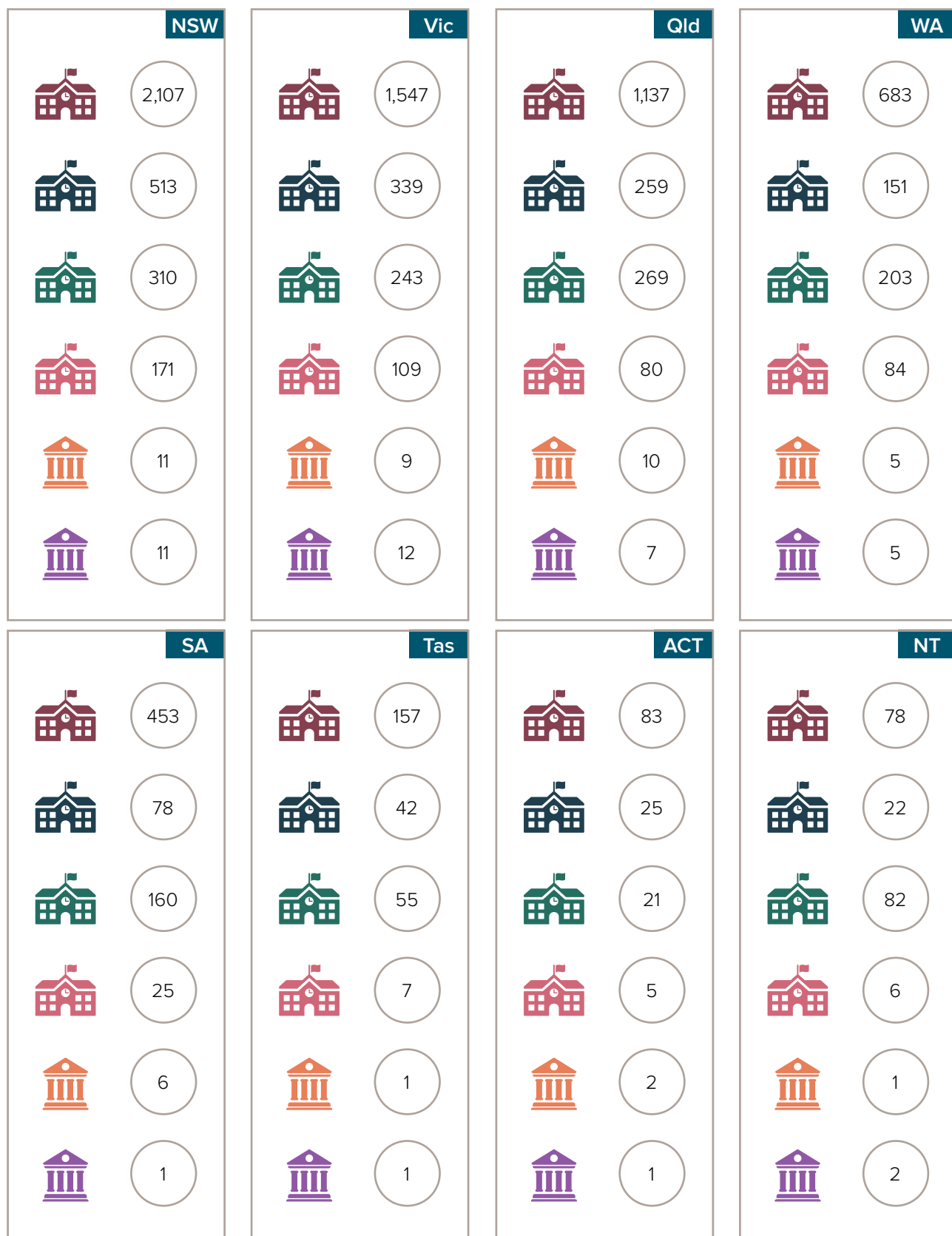
Customer



4 million students

across Australia participate in **VET student programs** ¹²⁷

Scale – by state and territory



 Total number of primary schools
  Total number of secondary schools
  Total number of combined schools^a
 Total number of special schools
  Total number of universities
  Total number of TAFE providers

Note: All school assets are inclusive of both private and public schools. a. Combined Schools provide both primary and secondary education.

Source: Based on EY analysis for Infrastructure Australia and supplementary engagement with relevant jurisdictions.

6.3 Education

Sector overview

Education infrastructure supports the delivery of high-quality educational outcomes. On an individual scale, a high-quality early education environment can improve the chances of children achieving better learning outcomes while at school, which in turn can enhance broader learning, health, employment and wealth outcomes later in their adult life. On a national scale, education infrastructure directly impacts our workforce participation, global competitiveness, increased social cohesion, wellbeing and productivity as a nation.

Education infrastructure is the buildings, facilities and campuses which support learning for both children and adults, including:

- **Early childhood education:** Childcare centres and preschools provided to children aged up to five years. Centres and preschools can be provided by local governments or private entities.
- **Primary and secondary education:** Primary and secondary schools, combined schools and special needs schools provided for children aged between five and 18 years. Schools can be provided by state governments, religious or independent organisations.
- **Tertiary education:** Universities and vocational education facilities provided for adults. Tertiary education institutions are provided by a range of public and private entities.

This Audit focuses on all three types of education infrastructure.

At a glance

This section finds challenges and opportunities for three types of education infrastructure:

- Fragmented governance of early childhood education infrastructure (including childcare centres and preschools) creates varied user outcomes.
- Demand for primary and secondary education is rising in our fast-growing cities and falling outside them. Assets lag behind new technology and the rising demand for joint and shared use from communities.
- Infrastructure maintenance for tertiary education is a challenge, and poor integration with other types of infrastructure can hamper growth.

Access to high-quality, affordable early childhood education is varied

Early childhood education is the foundation of lifelong learning which can influence individual and community quality of life and contribution to society. The early education sector has a central focus on a child's learning, development and wellbeing, particularly in supporting the immediate transition to primary school education. However, access to high-quality and affordable services varies due to governance and management fragmentation.

Early childhood education services are provided by a mix of public, private, and not-for-profit providers, and most centres are government funded or government subsidised. In September 2018, 12,853 approved childcare services operated in Australia, under the National Quality Framework (NQF), caring for just over 1.3 million children (around 68% of all Australian children aged 0-5 years).¹²⁸ A further 342,000 children aged four or five are enrolled in a

preschool program, while some children also attend state-regulated services outside of the NQF, such as occasional care.¹²⁹ Demand for early childhood education is expected to increase as Australia's population grows. By 2034, children aged five years and under will make up 14.7% of Australia's total population, requiring a potential additional 35,000 childcare centres, at current average ratios.¹³⁰

In Western Australia and Tasmania early childhood education services are largely delivered on school sites. In Queensland and New South Wales they are generally delivered in long day centres and standalone kindergartens. The complexity of the sector will increase as some jurisdictions look to implement universal preschool for three year olds.

This complexity impacts the quality, accessibility and cost of early education infrastructure. The facilities used to support the delivery of early childhood education varies substantially between providers, geographies and jurisdictions. Early childhood



education is not well suited to online provision given the nature of early childhood development and the important secondary role it plays as child care. As a result, the physical location and facilities are critical.

Lack of supporting infrastructure such as adequate transport connections can also reduce the accessibility of early education infrastructure. In our fast-growing cities, the location of childcare centres can create access challenges and additional congestion for transport networks, if parents or carers need to make additional trips to drop off or pick up their children. In all of our fast-growing cities, accessing early education infrastructure is a challenge by public transport, meaning parents are more likely to drive to drop off and pick up their children.¹³¹

The distances between early education centres, especially in rural communities and remote areas,

reduces local accessibility. In these areas, there is a marked decline in preschool attendance for Aboriginal and Torres Strait Islander children (which is not present for other children in these areas).¹³² This potentially speaks to barriers of both cost and transport accessibility for these families.

The sector's complexity also makes the quality of infrastructure difficult to understand or assure. The establishment of the NQF in 2012 has provided more transparency and assurance. The framework specifically outlines the physical environment standards for early childhood education providers, including fit-for-purpose design and specific maintenance requirements. This has been a significant step towards ensuring a consistent level of quality across our early education facilities. However, these standards are still subject to interpretation and providers are subject to different regulations between jurisdictions.

100. Challenge

Early childhood education services are delivered by a mix of public, private and not-for profit providers, creating fragmented infrastructure delivery and quality. Without action, continued variation in the quality of facilities may create poor educational outcomes for some children, and exacerbate challenges for parents in accessing and paying for services.

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Where this will impact:



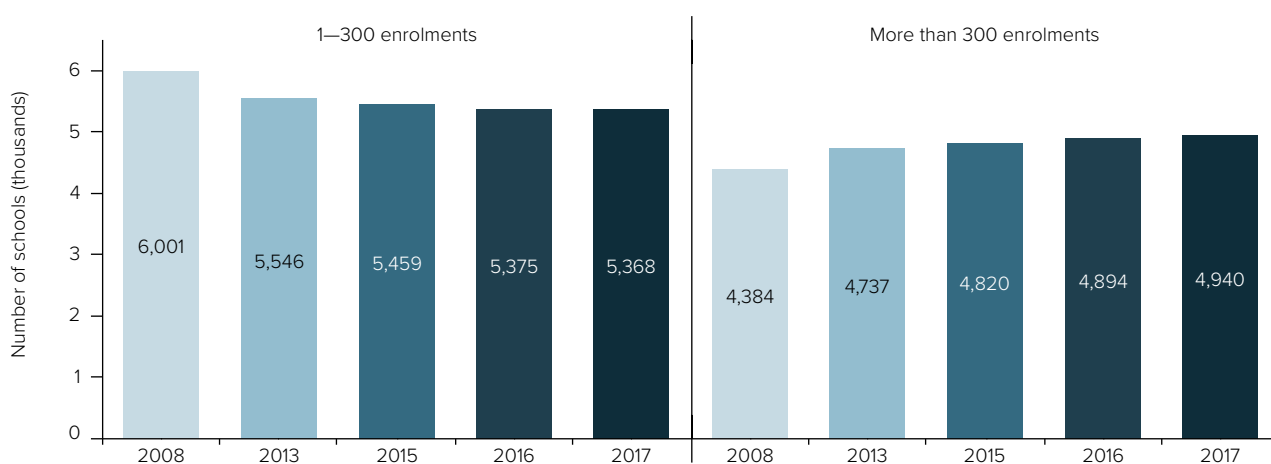
Demand for schools is increasing in fast-growing cities

In 2017 there were 6,228 primary schools, 1,408 secondary schools, 1,336 combined schools and 472 special schools with 3.9 million students in Australia – a 51,000 increase in the number of students from the previous year.¹³³ The number of schools across Australia increased by 30 between 2016 and 2017.¹³⁴ Around 70% of our schools are government owned and managed.¹³⁵

The average number of students enrolled per school has increased as the growth in students outstrips the numbers of schools. As Figure 2 shows, the number of schools with over 300 students has steadily increased, while the number of schools with fewer than 300 students is decreasing. These larger schools are generally located in fast-growing cities.

Over 70% of Australia's population growth is expected in our four largest fast-growing cities over the next 15 years, presenting a significant funding and planning challenge for states and territories to provide the number of schools required to meet demand.¹³⁶ Total primary and secondary school enrolments are projected to increase by almost half a million students between 2019 and 2027.¹³⁷ The challenge of increasing demand is most pressing in Sydney, Melbourne and Brisbane. Some large satellite cities are also experiencing an increase in demand, including Geelong and Ipswich. There are schools in fast-growing cities, particularly in inner areas, currently accommodating more students than they have capacity to. Overcrowding can lead to poor student outcomes, for example a reduction in other spaces, such as playgrounds or art and music classrooms, to accommodate additional students,¹³⁸ or can require building upgrades or changes, such as widening corridor spaces to avoid congestion.¹³⁹

Figure 2: The average number of students per school has increased since 2008



Note: These enrolments cover both government and non-government schools, and both primary and secondary schools.

Source: Australian Bureau of Statistics (2018)¹⁴⁰

101. Challenge

Demand for school infrastructure is increasing in our fast-growing and satellite cities, particularly in the inner city and outer growth areas of fast-growing cities. Without action, increased demand will create overcrowding in schools, and impact the quality of infrastructure and educational outcomes for students.

When this will impact:

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Where this will impact:



School capacity is inadequate for projected demand in fast-growing cities

State and territory governments are often playing catch up to respond to increased demand and deliver increases in school infrastructure capacity in fast-growing cities. Traditional approaches, coupled with existing spatial and demographic complexities, make it difficult for governments to deliver new or expanded schools when they are required. While new models for increasing capacity are emerging, governments have been slow to adopt them.

The most common approach to increasing school capacity is the use of demountable (or relocatable, transportable) classrooms. Demountables can be prefabricated, transported, installed, and removed quickly, making them well suited to address rapid changes in demand for space. The Northern Territory planned to invest \$8 million in additional demountable classrooms from 2018 to 2020 to support rapid increases in student enrolment numbers.¹⁴¹

However, in areas where there is consistently increasing demand, demountables do not provide an equitable or sufficient long-term infrastructure solution. Across the country it is not uncommon for demountable classrooms to be installed and remain onsite for over 10 years. This can primarily create issues of space for other land uses within schools, such as play areas.

There is little available data on the number, age, condition and time period of demountable buildings being used in schools, which makes the extent of the issue difficult to examine. While new demountable buildings can provide high-quality facilities such as wet areas and air conditioning, older demountable buildings are also more likely to contain asbestos, making them difficult and more costly to relocate. The Western Australian Parliament noted that there were over 50 schools with more than ten demountable classrooms in 2016, and one school had a total of 36 demountables onsite at that time.¹⁴² States and territories are increasingly recognising that demountables are not a permanent infrastructure solution, however the time and funding required to deliver appropriate permanent solutions present challenges in catching up to increasing demand.

The existing maintenance backlog at schools in the majority of states and territories is a further challenge faced by governments when responding to increased demand. Where existing schools are expanded to accommodate a larger number of students, the project often initially requires a substantial maintenance and infrastructure upgrade. This comes at an additional cost to governments, and can create issues of equity with other schools in the area which may also require maintenance upgrades but do not receive them without prioritised investment to expand.

There is also a spatial complexity to the demand for school infrastructure in fast-growing cities. One of the challenges with building or upgrading schools in established inner-city areas is the scarcity and high cost of available land. School infrastructure planning in established areas is generally more reactive to demand and capacity issues, and major development proposals. There can also be the added complexity of demographic changes within suburbs. For example, some parts of inner Sydney and Melbourne currently have a large number of school-aged children but many schools that previously existed in these areas were closed by governments in the 1990s and early 2000s due to a temporary lack of demand and an assumption that families would not reside in inner city areas.¹⁴³

In contrast, the provision of schools in greenfield areas and regional areas with lower levels of density is often easier than inner-city areas. More land is available and affordable in greenfield areas, allowing for easier planning and provision of new schools that address gaps in the broader network of schools for an area. However, governments often have difficulty securing these sites early enough to generate significant savings on land cost, and delivery of the school infrastructure tends only to occur after initial residential development.

A further spatial complexity to the demand for school infrastructure in fast-growing cities is unforeseen growth in particular areas. Projected demand for school infrastructure – like most social infrastructure planning – is generally based on locational birth data, adjusted for average levels of overseas and interstate migration.

However, this approach often does not capture the full extent of actual future population growth, particularly in our fast-growing cities where people are increasingly locating at all stages of life for a variety of reasons, including access to employment opportunities, moving closer to family, or access to education infrastructure. Within these cities, families are also increasingly living in higher-density areas and in smaller homes, including apartments. Additional school-aged children living in an area where they were not born can increase demand for school infrastructure that is not captured by projections.

The ability to access schools, easily and quickly is also a challenge in some areas. In our fast-growing cities, congestion modelling shows that additional trips taken in the morning peak to drop children off at school can exacerbate congestion.¹⁴⁴ In each of our fast-growing cities, the difference between road and public transport average travel times to the nearest school is stark. Accessing schools by public transport takes significantly longer than it does by car.¹⁴⁵

Delays in new school delivery or perceived issues with the quality of local schools can result in families developing links to other schools further afield. When children travel outside their local area for school, travel demand can increase, schools in their local area may be underutilised, local social networks may not be established, and demand can grow in areas that already have appropriate capacity for the local population.

New design approaches are emerging, and they provide governments with an opportunity to better manage their assets. These include vertical schools and school buildings that allow flexibility in their uses, such as levels which can be rented out as office space. New physical spaces within schools can also assist in tailoring learning for students. For example, the Adelaide Botanic High School in South Australia is a newly-built vertical school of seven storeys in the Adelaide CBD, with a focus on Science, Technology,

Engineering and Mathematics learning, including maker spaces, specialised engineering equipment and a research centre.¹⁴⁶ New models require careful consultation with educators, students and parents to ensure positive learning outcomes and support student welfare.

Similarly, new approaches to procuring services and resources for schools (including maintenance and infrastructure upgrades), such as bundling of schools into packages and use of public-private partnerships, provide governments with the ability to create economies of scale and efficiencies in procuring school services, ongoing maintenance and infrastructure upgrades. However, there are challenges in reforming procurement methods, which can add to cost and time even if planned and managed well, especially if they are the first of their kind in a jurisdiction. Uptake has therefore been slow to date.

102. Challenge

Traditional approaches to increasing the capacity of school infrastructure, such as using demountable buildings, are not adequate for the demand projected, nor necessarily appropriate for student outcomes. Maintenance backlogs and space constraints provide additional complexity. Without changes to the way demand is evaluated and new capacity provided, schools in fast-growing cities will be unable to meet growing demand, risking reduced quality of education outcomes for students.

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Where this will impact:



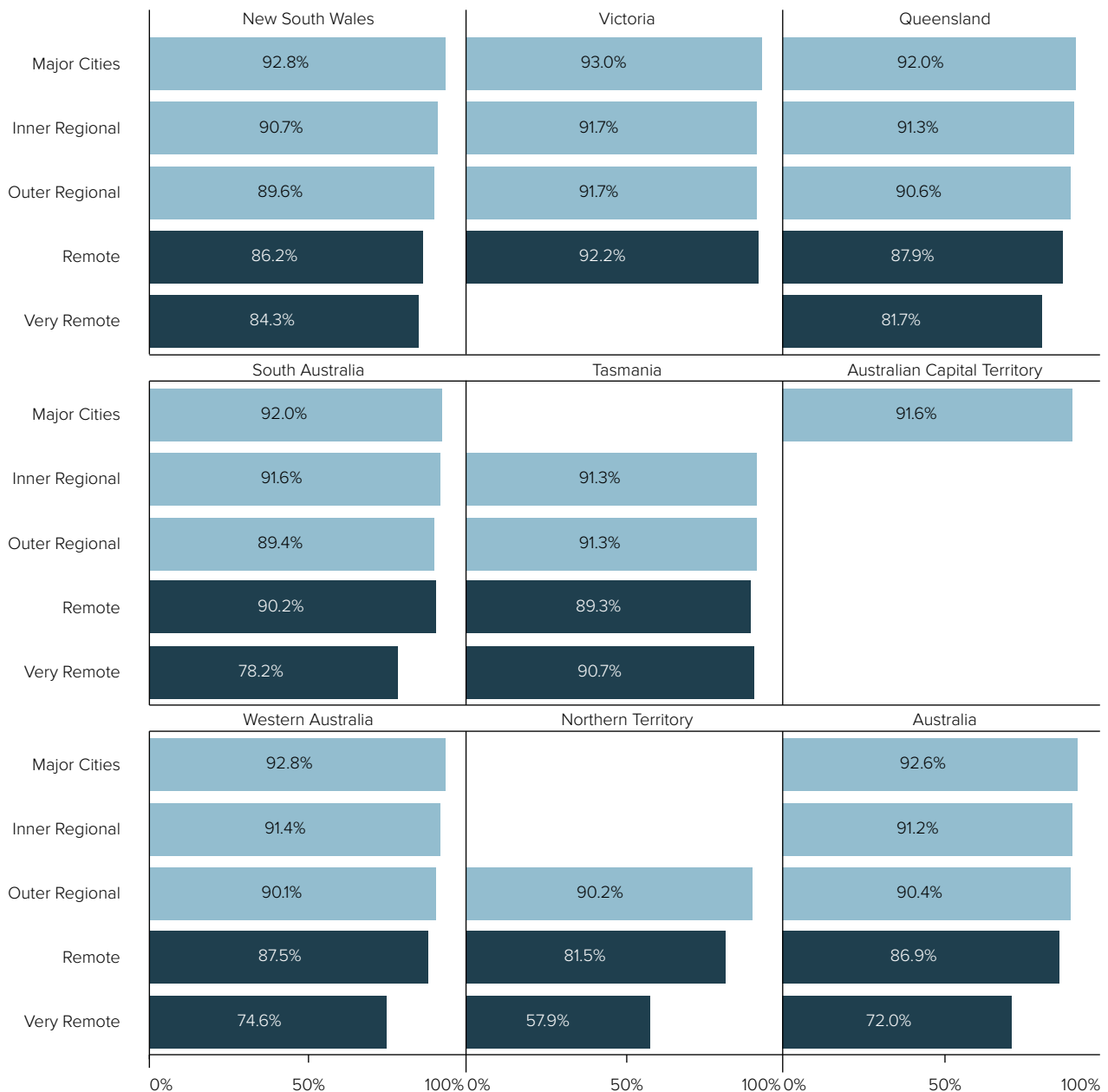
Demand for schools is declining in some smaller cities, and rural communities and remote areas

Declining populations in some regional centres and in many rural communities and remote areas pose different challenges for school infrastructure planning to our cities. The school-aged population is shrinking in some small communities, meaning schools in these areas may struggle to provide a full curriculum or attract investment for new infrastructure.

Student retention rates in outer-regional, remote and very remote areas are lower than in major cities and inner-regional areas. As Figure 3 shows, in 2018 school attendance rates across years 1–10 was lower in more remote areas. Attendance rates impact education outcomes, with reduced attendance resulting in poorer educational attainment. Schools in rural communities and remote areas with declining populations are being forced to adapt to shrinking class sizes with fewer resources to offer a diverse and rich curriculum.

Governments are facing a number of difficulties addressing this issue, resulting in reduced accessibility and education quality for communities, and greater costs for governments. Some jurisdictions are closing schools, leading to reduced access and availability of choice for families who remain in regional and remote areas. When school closures occur, remaining students have to travel longer distances to reach other schools. Families may leave the area, which further contributes to decline in the local population. Subsequently, if closed school infrastructure is no longer maintained or open to the community there may be a loss of core facilities for local community and sporting groups.

The maintenance backlog facing government schools in rural communities and remote areas further exacerbates the issue. Schools in these areas are often in poor condition. This can be due to a lack of funding for maintenance or an inability to access alternative revenue sources. The maintenance task may create further decline which could deter government investment as the work required increases in scale and cost, resulting in poor quality outcomes for students and teachers.

Figure 3: School attendance rates decrease as remoteness increases

Note: Percentages show attendance rate for students in years 1 to 10 in 2018.

Source: Productivity Commission (2019)¹⁴⁷

Where there are resources available, regional and remote communities are working hard to address student retention rates by providing classes and facilities that link directly with local job opportunities. While this can be effective, it is costly and generally limited to schools in towns with strong local economies. It also requires effective collaboration with government and vocational training providers, which can be challenging given competing priorities.

New models like Aurora College in New South Wales provide access for secondary school students in rural and remote locations to a selective strand of teaching which may not be provided by their local school. It uses digital technologies like video conferencing and personal contact to deliver the curriculum. Students are enrolled both in the selective class and also in their local school, meaning that they can access a challenging academic program without leaving home and friends to do so.¹⁴⁸

103. Challenge

Schools in some smaller cities, and rural communities and remote areas, are facing reduced demand, as populations in these areas decline and age. Without action, these communities will be forced to reduce educational services and infrastructure provision, potentially resulting in fewer resources to provide rich and diverse curricula to students.

When this will impact:



Where this will impact:



Ageing school buildings are not fit for purpose for 21st-century learning

Maintaining and upgrading existing school infrastructure is a challenge for governments. Many of Australia's school buildings are ageing, with some dating back to the 19th century.

Figure 4 presents the construction year of Victorian school buildings, with a 2007-11 spike due to the Australian Government's Building the Education Revolution program (BER). BER saw a \$16 billion investment for refurbishments, and construction of new class rooms, libraries and multipurpose halls.¹⁴⁹ Almost half of Victoria's school buildings are over 25 years old, and in New South Wales the average age is 46 years.¹⁵⁰

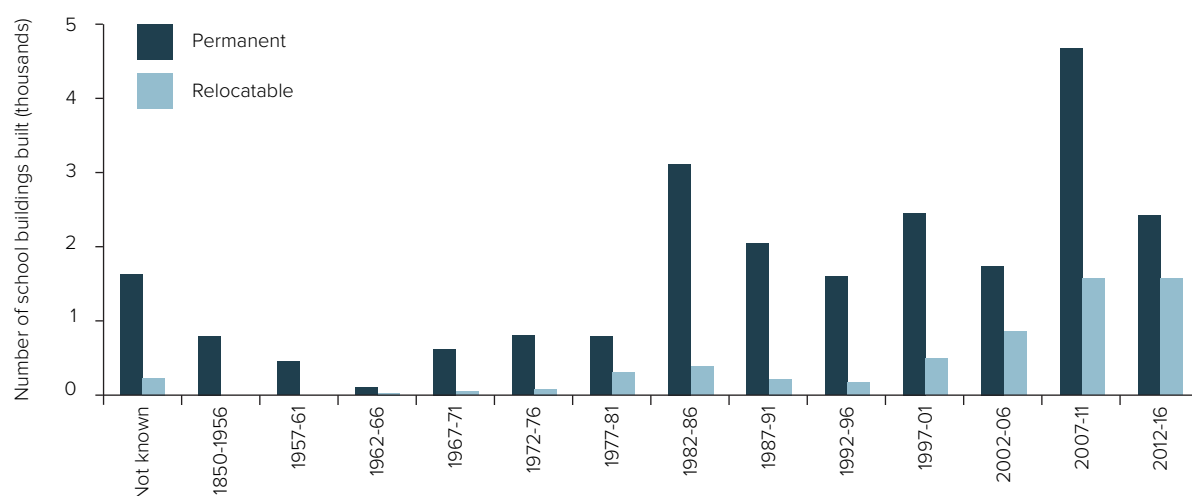
Compounding this challenge is an ongoing shift in the way we teach and learn. Teachers are harnessing new, more flexible, approaches to delivering curricula. These approaches often leverage new technologies and aim to improve learning experiences for students. Changes to the way we teach extends

to the buildings and spaces of classrooms and other supporting facilities, such as offices, specialty learning spaces and playgrounds, which most often require upgrades to facilitate the delivery of 21st century learning approaches.

In schools, older buildings and demountable buildings often have rigid and inefficient floor plans that do not provide flexible learning environments, detracting from student learning experiences. This means that ageing school buildings struggle to meet 21st-century learning expectations for flexible and adaptable spaces enabled for technology, collaboration and personalised learning experiences. Functional upgrades are predominantly focused on addressing these issues.

Students are also learning in different ways to previous generations. Growing up with rapidly evolving digital technologies and access to the internet means that students today process information and think in different ways, meaning curricula and classrooms must adapt to meet different demands.

Figure 4: Almost half of Victoria's permanent school buildings are over 25 years old



Note: The figure only includes data on buildings used for curriculum purposes. Non-curriculum buildings include relocatable buildings in storage.

Source: Victorian Auditor-General's Office (2017)¹⁵¹

A series of programs using digital technologies are also being implemented in response to the need for more flexible learning styles and to connect rural and remote students. For example, the 'flipped classroom' concept enables students to access video or other resources across a breadth of subjects in their own time, while face-to-face class time is used to discuss concepts and expand thinking.¹⁵² Models like this require access to digital infrastructure (both in the classroom and at home) and so classrooms need to be flexibly designed to enable both traditional learning settings (such as blackboard learning) and more informal settings.

In particular, digital connectivity and literacy is critical for future learning and reducing the barriers of time, distance and cost, especially in Northern Australia and other remote areas.¹⁵³ Digital connectivity is also a challenge. A New South Wales Auditor-General report concluded that many school wireless networks do not have the capacity to deal with current and future needs.¹⁵⁴ This creates a significant cost for governments and can reduce the quality of student learning. Some jurisdictions have established new authorities, such as the Victorian School Building Authority and School Infrastructure NSW, to help prioritise and coordinate school infrastructure upgrades and delivery and ensure schools are equipped with the right tools for 21st century learning. These bodies are also helping to assess and reduce the backlog of maintenance and improve overall asset management.¹⁵⁵

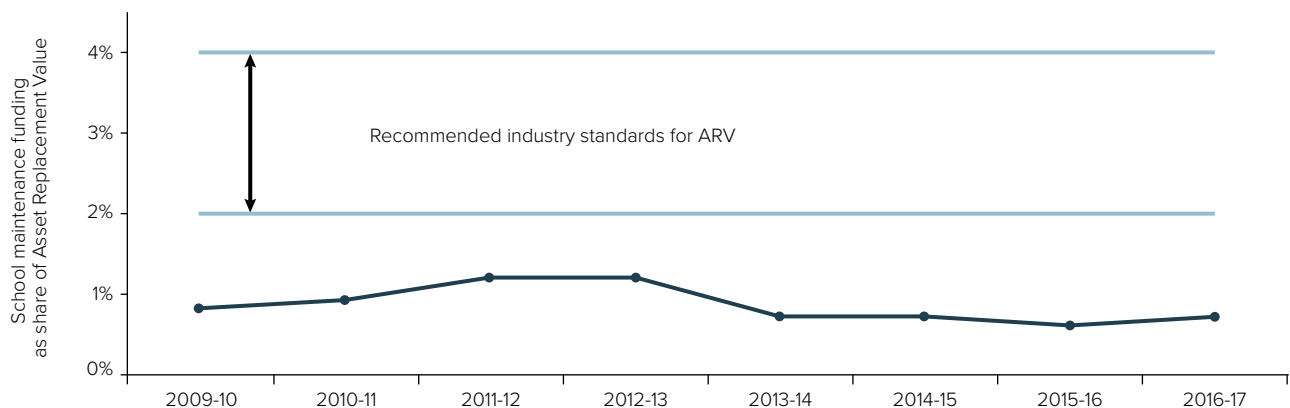
Ageing school infrastructure often requires significant maintenance upgrades, which are exacerbated by poor maintenance planning, a lack of funding, and safety issues such as asbestos inside building materials. Most states and territories have identified issues across their portfolios and in current maintenance planning and funding processes. These issues contribute to a nationwide backlog in school maintenance and a notable underspend compared to industry standards. As Figure 5 shows, school infrastructure maintenance funding in Victoria made up

between 0.5% and 1.2% of the total Asset Replacement Value (ARV) between 2009 and 2017. This is lower than the industry standard of 2% to 4%, also shown in Figure 5. Given the current maintenance backlog, and planning and funding issues, government departments are often forced to respond to maintenance reactively and with short-term solutions. This has resulted in poorer quality buildings and facilities for both students and staff, and has lowered the value of school portfolios for governments nationwide.

Governments also face administrative challenges when maintaining school buildings. Outdated and disjointed systems, inconsistent data collection, differing views on best practice and the nature of maintenance funding make it difficult to understand the true extent of maintenance requirements. Further, delegated responsibility for maintenance makes accountability and sufficient skills difficult to assure. For example, both New South Wales and Victoria have devolved most decision making to school principals, including maintenance works within certain categories and monetary thresholds.¹⁵⁶

Ageing school infrastructure also limits accessibility. There has been a national shift towards including students with disability in mainstream schools and classrooms. However, without infrastructure upgrades, many classrooms cannot adequately support children with physical or intellectual impairment. In response to this specific issue, the New South Wales Department of Education has recently released a Disability Strategy that states the Department's intention to 'redesign learning spaces so that they meet the needs of the full range of students, by strengthening the early involvement of disability education specialists in our designs, builds and refurbishment work'.¹⁵⁷ Accessibility upgrades are often included as part of broader functional upgrades. However, the age of existing buildings makes these upgrades more costly as the scope is expanded to include accessibility upgrades and critical maintenance.

Figure 5: School maintenance funding in Victoria as a percentage of Asset Replacement Value (ARV) has been lower than the industry standard



Source: Victorian Auditor-General's Office (2017)¹⁵⁸

104. Challenge

Much of Australia's school infrastructure is ageing and not fit for purpose for 21st-century learning. This includes a lack of flexibility to adapt to new technologies and teaching models, or buildings which are not accessible for all students. Maintaining and upgrading buildings is costly for governments and disruptive for learning outcomes, however without action, Australian schools risk falling behind other countries in preparing students for work and life in the 21st century.

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Where this
will impact:



Communities increasingly use school infrastructure

School assets are some of the most consistently underutilised assets owned by government. They are mostly used between 8 am and 4 pm, five days a week, and are often unavailable for non-school use at other times. In urban areas, particularly fast-growing cities where space is scarce and land prices are high, this means that valuable land and publicly-provided facilities (such as sporting fields, courts or halls) are underutilised.

Administrative and policy barriers, along with risk (including potentially for student safety) and insurance concerns, often prevent schools from opening up spaces to the public or sharing use with particular groups. However, some jurisdictions and individual schools are effectively partnering with local groups (such as sporting clubs) or the private sector to arrange joint use of school infrastructure to overcome underutilisation, to leverage the location of their assets (often in the centre of communities) and to tap into additional revenue streams. Sharing school infrastructure can also help to deliver broader services to the community, while improving learning outcomes and specialised skill development for students. This improves utilisation, increases access to green and recreation infrastructure, and provides opportunities to share the operational and maintenance costs of the facilities.¹⁵⁹

Expanding the role of schools beyond education to act as community hubs has become increasingly important in fast-growing areas, where land and space have become harder to access and increasingly costly. In rural communities and remote areas, school infrastructure can also play multiple roles when single-purpose infrastructure is too expensive or difficult to deliver and maintain.

The majority of states and territories have clear policies and procedures for facilitating community use. The Department of Education in Western Australia requires all school facilities to be made available for use by Technical and Further Education WA (TAFEWA), the community and other users.¹⁶⁰ In New South Wales, a legally binding Joint Use Project Agreement (JUPA) must be negotiated and signed by the Department of Education and other parties to agree the terms and conditions for projects involving public property and facilities prior to any construction or joint use commencing.¹⁶¹ South Australia is less formal in their approach, providing a template form devolving responsibility to school principals for how they engage community users up to a certain value threshold.¹⁶² However, barriers to widespread sharing arrangements remain. These are often outside of government control, including the willingness or capacity for school principals to negotiate rates and agreements with external parties. The complexity of systems in place to enable shared use of space can also deter community members from engaging with schools.

Access to additional revenue streams is a key benefit of community use. Schools have increasingly identified and pursued opportunities to generate revenue that can be reinvested into the school, staff and students. For example, several programs have been established in recent years to encourage the installation of solar panels onto school roofs to reduce energy costs and potentially generate a revenue stream for schools.

Aspley Special School, Brisbane

Community use of school assets can contribute directly to student outcomes. The Kingfisher Recycling Centre onsite at Aspley Special School, in Brisbane’s northern suburbs, is an example of how school sites and facilities can be used to support student outcomes, whilst simultaneously generating revenue for the school.¹⁶³

Aspley Special School provides individualised programs for secondary students with disability. In 1983, Aspley Special School partnered with community volunteers to introduce an on-site recycling program that supported skills-based

training for students. The program originally trained students in can crushing as a work-experience option. Today, the school has its very own recycling plant on site – Kingfisher Recycling Centre. The program is run in partnership with Brisbane City Council, Keep Australia Beautiful Queensland and other local businesses, and generates over \$50,000 in revenue annually.¹⁶⁴ The centre processes a variety of recyclables and provides all students with skills-based training in e-waste processing, can crushing, glass sorting, cardboard packing, lid removal, stamp recovery, tree planting and mulching.



105. Opportunity

School infrastructure can provide essential community facilities and spaces, such as sporting fields and halls, however, access to school infrastructure is often restricted to ensure student safety and reduce maintenance costs for government. Harnessing the benefits of school infrastructure for community use outside of school hours, particularly in fast-growing cities where space is scarce, can improve the efficient use of education infrastructure assets and improve health and social wellbeing outcomes for people.

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Where this will impact:



The total demand for tertiary education infrastructure is increasing

The higher education sector makes significant contributions to Australia's national productivity and wellbeing. As a key and growing economic sector, it plays an important role in our export economy, particularly in the Asia Pacific. Tertiary education and research also contribute to improved knowledge and wellbeing of Australians, and increases our capacity for innovation.

Over the past 30 years, Australia's tertiary education sector has moved away from a more exclusive system of post-secondary education, particularly focused on universities, towards providing more universal access to higher education. This has led to an increase in domestic and international student enrolment numbers.

As Figure 6 shows, between 2001 and 2017, the number of domestic students increased by around 50% and the number of international students more than doubled. The number of university staff and researchers has also increased over this period. This means many more people are travelling to and using university infrastructure across Australia.

This trend is set to continue over the short and medium term as tertiary education remains one of

the Australian economy's key export industries, and the presence of universities in fast-growing cities continues to increase. Several major universities that attract international students are located in inner-city Sydney and Melbourne. For example, the University of Melbourne's share of international students alone increased from 29% in 2013 to 40% in 2017.¹⁶⁵ Fewer international students are drawn to regional areas, with Queensland having the largest percentage, at only 5%, of international students locating outside of major cities.¹⁶⁶

Outside of fast-growing cities, tertiary education institutions can also play a critical role in supporting the local economy of regional centres. For example, specialist marine research and teaching infrastructure at James Cook University attracts people and jobs to Townsville in Queensland.¹⁶⁷

In contrast to universities, vocational training providers have experienced a marginal decrease in the number of government-funded students between 2012 and 2017, as shown in Figure 7 below. This is most likely due to the increase in number of private providers. However, unlike secondary education, participation in vocational training increases as remoteness increases. In 2016, the participation rate in vocational education was 6.5% in major cities, 10.6% in regional areas and 12.5% in remote areas.¹⁶⁸

106. Challenge

Demand for tertiary education infrastructure is increasing, particularly for universities in fast-growing cities, and for vocational training in smaller cities, and rural communities and remote areas. Without action, universities and vocational education facilities will experience overcrowding, impacting on the quality of student outcomes.

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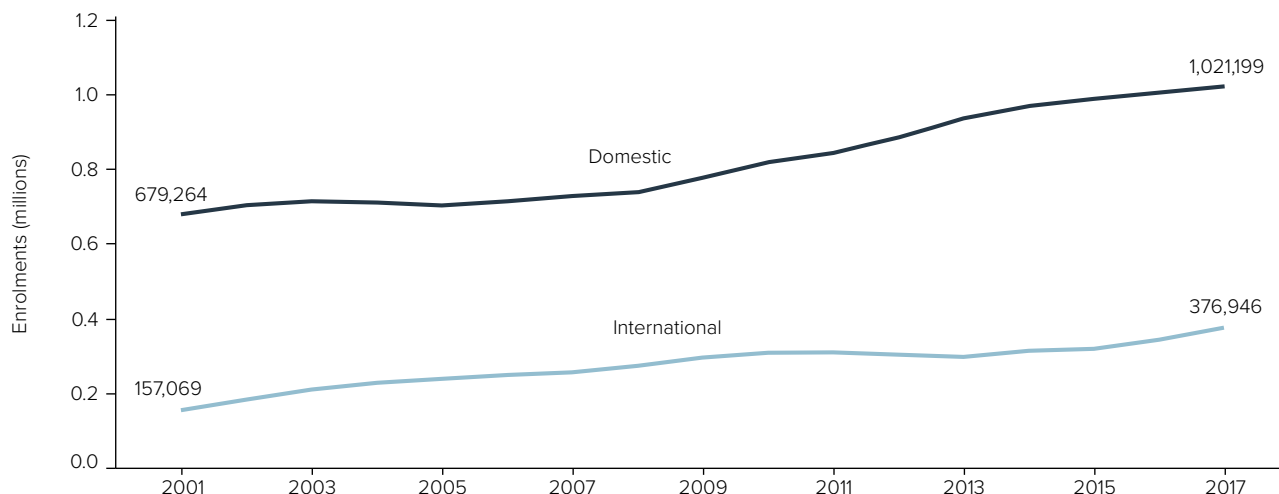
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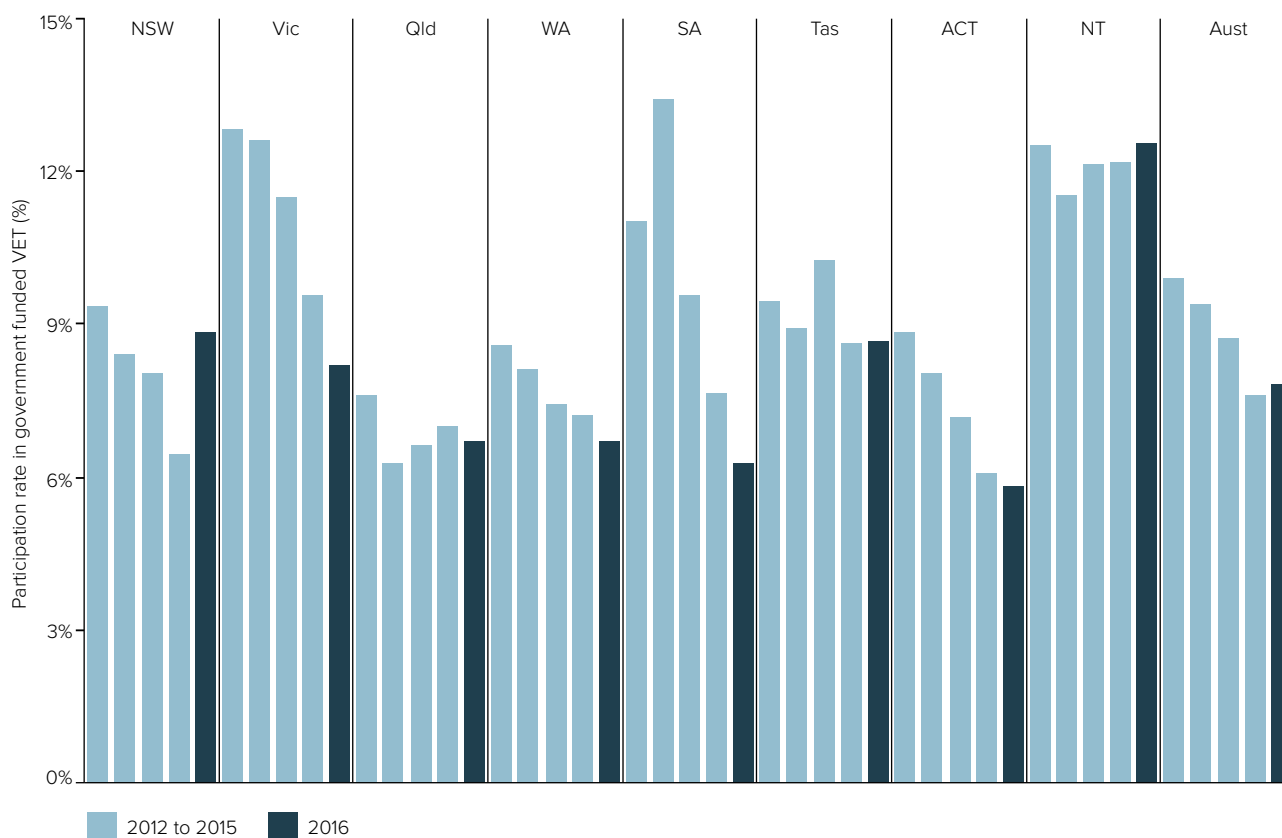


Figure 6: Over the past 16 years, domestic university enrolment has grown by 50%, while international enrolment has more than doubled



Source: Department of Education and Training (2018)¹⁶⁹

Figure 7: Participation rate in government-funded VET is decreasing



Note: Participation rate refers to the proportion of the population aged 15-64 years participating in government-funded VET.

Source: Productivity Commission (2018)¹⁷⁰



Access to vocational education infrastructure is a challenge in remote areas

While the majority of tertiary education providers are adapting to new learning approaches and technologies, including delivering courses more flexibly and online, access to vocational education is restricted by the location of facilities. This is because vocational training often requires practical, in-person experience. Regional centres generally provide adequate access to vocational education infrastructure and these institutions are often critical to the local economy.¹⁷¹ However, rural communities and remote areas have significantly lower levels of access to physical facilities.

Reduced access to adequate facilities can impact on the quality of educational outcomes. Facilities that support the delivery of technical education are often critical in a student's learning experience, and are difficult to replicate in a reduced access or online capacity. The Australian Government's recent *Independent Review into Regional, Rural and Remote Education* identified a lack of choice for students in remote areas when deciding where to study, and found these students are more likely to need to move further away from home to study.¹⁷² This increases the cost of study for students, adding the need to pay for accommodation to be located close to these facilities.

107. Challenge

Access to vocational education infrastructure is a challenge in remote areas. Students often have to travel long distances to reach teaching facilities. Without action, reduced access to tertiary education will deliver poorer educational and economic outcomes for communities in remote areas, particularly those with high socio-economic disadvantage who cannot afford to travel and stay in other areas to study.

When this will impact:

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Where this will impact:





Competing priorities are reducing the focus on maintenance for tertiary education infrastructure

In addition to being more disconnected than other types of infrastructure, universities experience similar challenges to schools in ensuring adequate maintenance is undertaken and facilities are functional and support current technology. In 2015 it was estimated that government funded universities had a total maintenance backlog of almost \$1.9 billion and deferred refurbishments to a value of \$2.2 billion.¹⁷³

In our fast-growing cities, many of our 'sandstone' campuses have ageing infrastructure, creating challenges for maintenance, despite having generous donors and significant funds under management.¹⁷⁴ At the same time, many larger universities are investing heavily in new infrastructure to attract and support emerging fields of research and increase both international and domestic student enrolments. For example in Sydney alone, the University of Technology Sydney has invested over \$1 billion in its campus redevelopment,¹⁷⁵ and the University of Sydney invested \$1.7 billion in its infrastructure between 2011 and 2015, and is currently expanding its footprint, investing a further \$500 million in developing a new education and research precinct at Parramatta and Westmead.¹⁷⁶

Reduced funding for vocational training infrastructure and the inability to make up the funding gap from alternative revenue sources can result in infrastructure that is not fit for purpose and a maintenance backlog that can be too difficult and expensive to address.¹⁷⁷ This is even more apparent in outer-metropolitan and regional centres, where attracting private funding and finance can be much more difficult than in fast-growing or smaller cities,¹⁷⁸ meaning functional upgrades and maintenance can be further delayed.

A lack of maintenance planning and the age of vocational education buildings compounds this issue further. For example, Victoria has 12 TAFE campuses across the state. A 2016 review identified that 11 of the 12 TAFE campuses lacked system support to help them capture, record and report on asset planning, which could then be used to better manage their assets and provide adequate maintenance.¹⁷⁹ New South Wales has 130 TAFE campuses – 32 in metropolitan Sydney and 98 campuses across the rest of the state. TAFE New South Wales also identified their main challenge as maintaining existing, ageing infrastructure, which could reduce their ability to compete with other training providers.¹⁸⁰

108. Challenge

Competing priorities are reducing the focus on maintaining ageing assets in tertiary education infrastructure. Without action, students may experience poorer-quality learning outcomes.

When this will impact:

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Where this will impact:



Tertiary education infrastructure is often disconnected from other infrastructure

University infrastructure has an increasing presence in Australia, as economic anchors in both our fast-growing cities and regional centres. The scale of university campuses, in particular, often encompasses multiple uses, including other social infrastructure services such as health, sport and recreation, and arts and culture. However, tertiary education infrastructure is often disconnected from other essential infrastructure, particularly transport and affordable accommodation.

Alignment between tertiary institutions and state and local governments on priorities for timing and funding, and the limited governance structures at a place or precinct level contribute to this challenge. In addition, legacy issues like suboptimal campus locations (outside of city or town centres), and newer trends like changing transport preferences, further exacerbate connectivity issues. Poor campus locations often results in students not being able – or simply not wanting – to live within close proximity. It also makes transport connections difficult to justify, as they are often considered a detour for major networks.

A further challenge is the nature of universities operating as private businesses, which makes integration of university infrastructure and broader public infrastructure more complex. A key challenge is when there is limited alignment between the priorities, timing or funding for a university and state transport authority. This can mean that the transport connections staff and students need to reach the campus are not delivered, reducing access to these education services.¹⁸¹

Public transport connectivity is vital for university infrastructure. Melbourne University states that 90% of close to 60,000 staff and students use public or active transport to reach its inner city campus.¹⁸² This creates greater demand for access to public transport infrastructure within proximity of universities, which can contribute to overcrowding in inner city areas, or create barrier to access for staff and students where campuses are located in areas not well connected by public transport services. Accommodation for students can also be a major challenge, particularly as the number of international students in Australia increases. Finding adequate, affordable and safe housing, close to tertiary education campuses is increasingly difficult for students in the inner areas of our fast-growing cities. Universities in these areas are investing in student accommodation infrastructure to help meet demand.

The Australian Department of Education and Training's *National Strategy for International Education 2025* includes an action to 'look for new ways to deliver and improve support services, affordable and convenient accommodation and public transport' and recognises that these support academic achievement and social connections.¹⁸³ Improved public transport access is therefore recognised as a positive influence on student outcomes at university. Macquarie University benefited from a new station in 2009 and University of Melbourne will have a new station in 2024.¹⁸⁴ There are also stations proposed for Monash University, Deakin University and La Trobe University as part of the Suburban Rail Loop.¹⁸⁵

109. Challenge

Tertiary education infrastructure is often poorly-integrated with other types of infrastructure, including transport and affordable accommodation. Without action, access to tertiary education infrastructure could be reduced for a growing number of students and employees, impacting more broadly on transport congestion and overcrowding, and potentially increasing costs for students.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Performance of green, blue and recreation infrastructure

Quality



The quality of **green, blue and recreational infrastructure** is considered better than all other social infrastructure ¹⁸⁶

Access

10%

of people in outer-urban areas expect access to green space to worsen over the next 5 years ¹⁸⁷

Cost



In 2018, Australians **spent twice as much** on recreation as medical expenses ¹⁸⁸

Cost

Couples with kids over 5 spent around

\$263

per week

on recreation in 2018 ¹⁸⁹



Access

8 million

people use **community sporting infrastructure** annually ¹⁹⁰



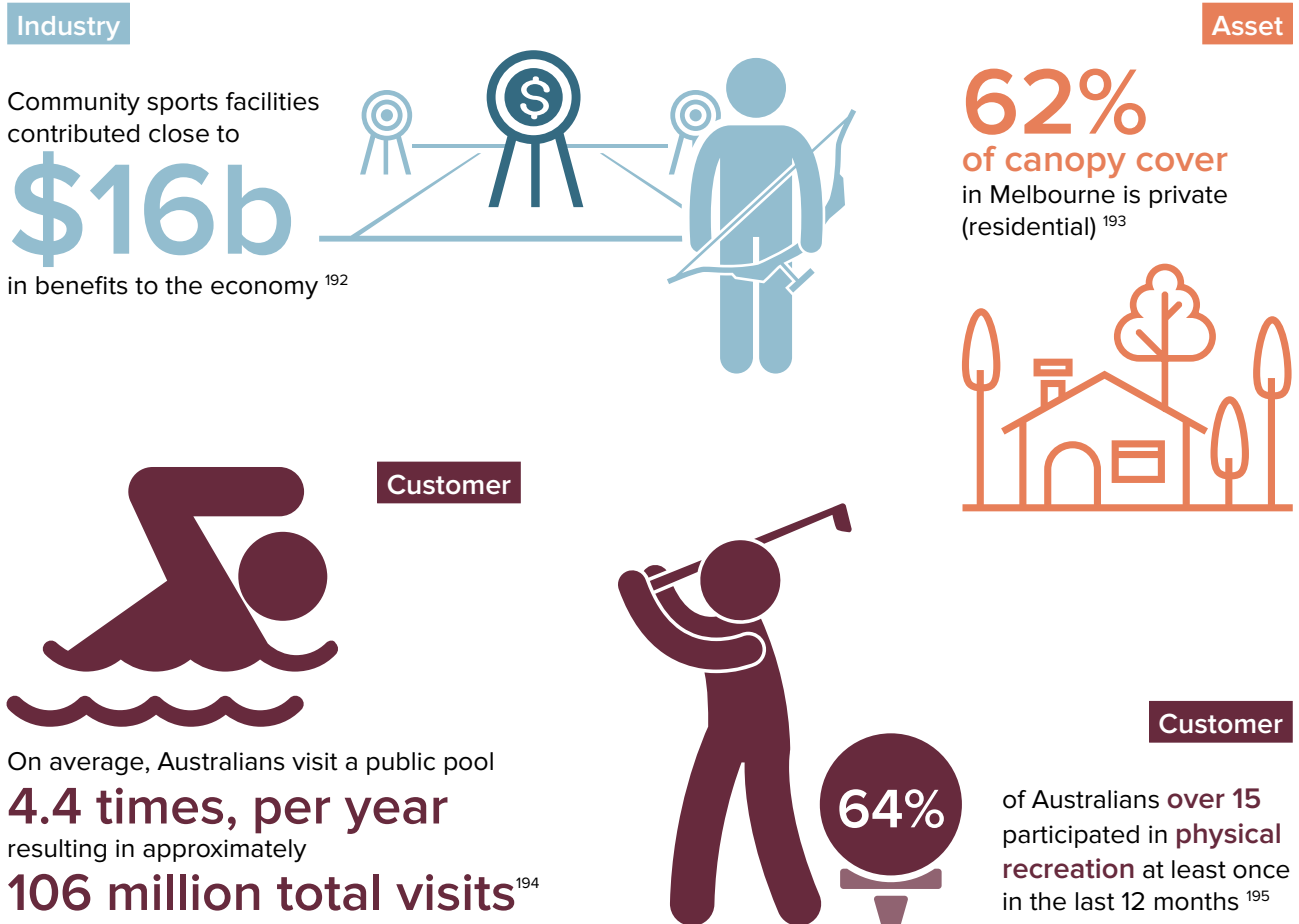
Quality

Over 1/4 of people

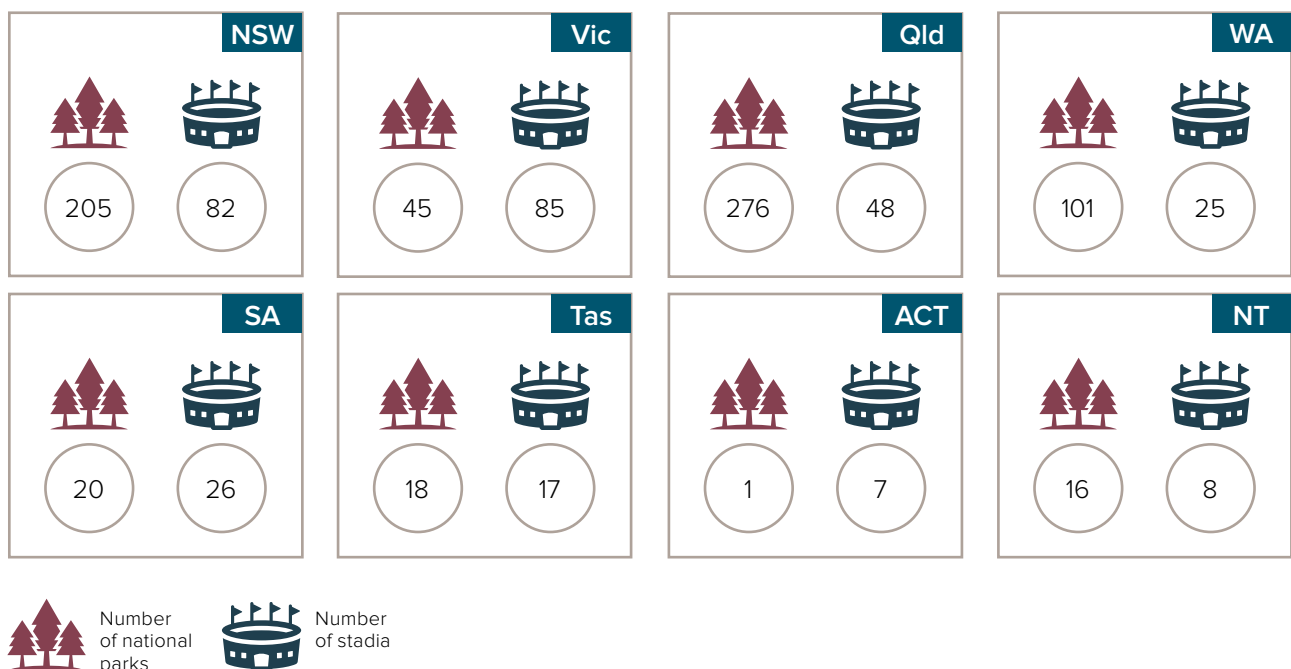
feel the quality of green space is likely to improve over the next 5 years ¹⁹¹



Scale of green, blue and recreation infrastructure



Scale – by state and territory



Source: Based on EY analysis for Infrastructure Australia and supplementary engagement with relevant jurisdictions.

6.4 Green, blue and recreation

Sector overview

Green, blue and recreation infrastructure are natural and built spaces which people use for active transport, to play sports and exercise, to relax, to learn and connect with their communities, culture, heritage and place. They can provide a wide range of social and economic benefits, build resilience and increase the health and wellbeing of communities.

- **Green infrastructure** refers to the range of natural and built landscape assets which incorporate natural vegetation. It includes areas of public and private land such as parks, fields, verges, rooftop gardens, green facades, walking and cycling tracks, street trees and backyards.
- **Blue infrastructure** refers to beaches and waterways, such as harbours and rivers, and the facilities that support them, including foreshores, surf lifesaving and water recreation clubs, jetties and wharves.
- **Recreation infrastructure** includes both small- and large-scale sports and community facilities. It can often overlap with green infrastructure. For example, many large parks include facilities for organised sports, or playgrounds for children. Recreation infrastructure includes:
 - Sports fields, grounds and stadiums
 - Public swimming pools
 - Playgrounds and skate parks
 - Community centres and libraries
 - Public spaces and the public realm.

This Audit focuses on all types of green, blue and recreation infrastructure.

At a glance

This section discusses the role that green, blue and recreation infrastructure plays in creating liveable, productive, sustainable and resilient places across Australia.

Recreation infrastructure provides broad social and economic benefits across communities. However, population decline, particularly in regional areas, can create maintenance pressures.

There is a lack of coordination across levels of government in planning, delivering and maintaining green, blue and recreational infrastructure, resulting in varying levels of quality and accessibility.

Population growth and densification in major cities are placing pressure on green, blue and recreation infrastructure, and it can be expensive to acquire and maintain new assets. The broader social and indirect economic benefits of this infrastructure are often poorly-quantified or undervalued in business cases for new investment or maintenance of existing assets.

Green, blue and recreation infrastructure are key to creating liveable and productive places

Green, blue and recreation infrastructure contribute significantly to the liveability and resilience of places and the wellbeing of people – whether it be a local park or walking track along a river, a public swimming pool in an inland town, or the local basketball or netball courts. These spaces and facilities are essential services that, alongside transport, energy, telecommunications and water, can help to create economically-productive, socially-cohesive and sustainable places. Improving access to and the quality of this infrastructure can therefore deliver significant benefits to the community, government and industry. These include reducing demand on other infrastructure sectors, such as transport through active transport corridors, acute health and mental services through preventive exercise or emergency care from surf lifesaving, and the electricity network through increased tree cover cooling our streets and buildings.

The health outcomes for individuals, and subsequently on health systems, are significant and well documented. The World Health Organisation points to a growing body of evidence showing the relationship between positive health and wellbeing outcomes and levels of green space in neighbourhoods, for example:

- Lower access to green space has been linked to increased incidence of chronic diseases such as obesity, Type II diabetes, osteoporosis and stress-related illnesses such as depression, heart diseases and mental fatigue.¹⁹⁶
- Higher access to green space can promote physiological effects such as lower concentrations of cortisol, lower pulse rate and blood pressure, greater parasympathetic nerve activity and lower sympathetic nerve activity compared to other urban environments.¹⁹⁷
- Proximity to parks has been associated with greater frequency of physical activity, reduced weight, lower coronary heart disease, and higher levels of social cohesion.¹⁹⁸
- Regularly using or seeing green and blue spaces can have positive effects on mental health outcomes.¹⁹⁹

Well-managed green and blue infrastructure supports the sustainability of our biodiversity and natural resources, and can improve air quality and cooling. There is intrinsic value in access to biodiversity and natural environments. Recreation infrastructure can support positive health outcomes for individuals and improved social identity and cohesion for communities.

Quality recreation infrastructure that supports a diverse range of activities for all ages and abilities is important for social interaction between neighbours and help support safe, healthy and connected communities.²⁰⁰ Co-locating a variety of activities is important too, to support diverse user groups. For example, designing a walking track around a sports oval enables carers to engage in physical activity whilst their child participates in sport.

There are real and significant economic benefits delivered by green, blue and recreation infrastructure in communities. Regular physical exercise improves health outcomes, resulting in less sick days at work (and therefore improving the productivity of the workforce) and less demand on the health system.²⁰¹ People place premiums on land which incorporates or provides access to these assets, and it can add value to other types of infrastructure and development. For example, the average effect on house prices from moving from the median distance to the first percentile of distance from a park are considerable, ranging from around \$8,000 to \$86,000.²⁰² Sporting precincts, such as Melbourne's sports and entertainment precinct, can attract local, interstate and international visitors, boosting economic activity and providing high-quality sporting facilities for local communities.

While they exist, these social and economic benefits are not as well quantified, documented or evidenced in government decision making processes as for other types of infrastructure. This means that green, blue and recreation infrastructure are often treated in isolation by governments, presenting funding challenges. The beneficiaries of new infrastructure will, more often than not, be nearby properties that increase in value, which is problematic to unlock. This leaves a perverse outcome where the economic benefits, such as through avoided health costs, may be high but it is not possible to identify a direct funding source. For example, transport projects, such as urban rail lines, often need to acquire expensive inner-city land but are able to subsidise the cost through value uplift and property development rights. These mechanisms are generally not available to deliver necessary green infrastructure.

Revitalising Newcastle is a \$650 million program delivering public spaces, light rail and a new public transport interchange to the inner-city of Newcastle, New South Wales. It provides a positive example of state and local governments collaborating on an urban renewal project with a focus on green infrastructure and place.²⁰³ Other jurisdictions have used public/private partnerships models to deliver and manage green infrastructure. For example, the Highline in New York is a public park that is built on a disused, elevated rail line. It is owned by the City of New York, but built and maintained by a non-profit organisation.²⁰⁴



110. Challenge

Investment in green, blue and recreation infrastructure is often not prioritised because the true costs and benefits are not well integrated into government decision making. Without action, essential green, blue and recreation infrastructure will not be delivered, reducing access for communities to spaces that improve liveability, health and environmental outcomes.

**When this
will impact:**



**Where this
will impact:**



Recreation infrastructure can help deliver broad community benefits

Recreational facilities such as sporting facilities, community centres, libraries, local swimming pools and children's playgrounds are critical to promoting social cohesion, building community resilience and creating vibrant places. They create spaces for communities to come together and interact, which can increase civic engagement and community empowerment. Recreation spaces like public streets and public squares have a role in improving physical activity, increasing local retail spend as well as the creation of more job opportunities. Research by the UK's Living Streets Organisation highlights that improvements to public spaces can boost footfall and business trading by up to 40%.²⁰⁵

Recreational infrastructure is closely linked to green infrastructure, often sharing space. Together they create spaces for community interaction and physical activity which helps to improve the physical and mental health of the surrounding community.

For example, a study for the Sports Australia investigated the value of community sports facilities in Australia and concluded they contribute at least \$16.2 billion annually to the economy, including:

- Personal health benefits and health system benefits contributed an economic value of \$4.9 billion
- Human capital uplift and green space benefits of \$5.1 billion
- Increased productivity and economic activity contributed an economic value of \$6.3 billion.²⁰⁶

In rural communities and remote areas, recreational facilities can play a crucial role in the community, promoting social interaction and wellbeing. For example, local football teams are often among the most resilient institutions in declining small towns, enduring beyond closed banks or post offices. However, reduced demand and increasing financial constraints in some towns means maintaining these assets will not be sustainable in the long term. Shared- and joint-use of recreational facilities with other infrastructure assets, such as schools, and multi-use facilities provide an opportunity to partially address some of the capital and operational funding challenges. This approach makes better use of an existing asset, or shares the cost of delivering a new one, and makes more space available to local communities.

In fast-growing cities, this approach can help to improve access to green spaces and recreation facilities, while overcoming scarce space for such facilities. As Australia's fast-growing cities become denser and more heavily populated, access to recreational facilities is likely to come under pressure. Similar to green infrastructure, high costs of maintenance and acquisition of land will be an ongoing challenge for governments.

For example, in 2018 the New South Wales Government launched the Share our Space program that allowed communities to access school playgrounds and ovals during the school holidays. Participating schools received a grant to help upgrade their facilities for community and school use. The New South Wales Department of Education and the City of Sydney have now signed an agreement for some new (and redeveloped) schools and the community to permanently share particular inner-city green spaces and sporting facilities.²⁰⁷ Shared use policies and programs also operate to varying degrees in other states and territories, including Western Australia,²⁰⁸ South Australia,²⁰⁹ and Queensland.²¹⁰



11. Opportunity

Joint- and shared-use of recreation infrastructure can solve space constraints in fast-growing cities, and help to overcome lower demand and funding constraints in rural communities and remote areas. Sharing spaces and facilities can improve access for communities to high-quality infrastructure and bring down costs for users and operators.

When this will impact:



Where this will impact:



Green, blue and recreation infrastructure management is fragmented

All levels of government and private landowners have an interest and role in the provision of green infrastructure and recreational facilities. However, there are gaps and inconsistencies in the way green infrastructure and recreational facilities are planned, delivered, managed and monitored by governments. Different responsibilities, resourcing and capabilities between governments and private landowners often lead to ad-hoc outcomes when it comes to providing sufficient green infrastructure and recreational facilities for growing and changing communities.

The Australian Government, through Parks Australia, manages six Commonwealth National Parks, the Australian National Botanic Gardens and 58 Commonwealth Marine Parks. It has a limited role in the provision of green infrastructure in urban centres but a strong interest in urban policy and creating liveable cities.²¹¹

State and territory governments are responsible for the management of state parks, major urban parklands (such as Kings Park and Botanic Garden in Perth) and major ports and waterways in their respective jurisdictions. Crucially, state and territory governments are responsible for strategic metropolitan and regional land-use and infrastructure planning.

Local governments are directly responsible for much of our green, blue and recreation infrastructure. They manage the provision, operation and maintenance of local parks, gardens, beaches, waterways and public sporting and recreational facilities. This local infrastructure has a significant impact on the perceived and actual liveability of a community. However, local governments often lack influence and resources to plan for green and blue infrastructure in an integrated way across jurisdictions. There are also resourcing challenges to plan, fund, deliver and maintain local green infrastructure.

Government investment in recreation infrastructure represents an opportunity to maximise outcomes for the community through good design that is integrated as part of a broader vision for the community. With long lifespans for this type of infrastructure, the procurement of these facilities need to ensure value for money for the taxpayer through consideration of their whole-of-life costs and broader sustainability features, such as energy, water and waste efficiency, resilience, and integration with public and active transport networks.

Private landowners are responsible for the majority of urban vegetation through private green spaces, such as backyards.²¹² Of course, there is no coordinated approach across private landowners to decision making on the green space under their control. This presents a key risk to the continued presence of private green spaces, notwithstanding the limited powers available to governments to retain these private green spaces.

The fragmentation of policy levers to control green infrastructure and recreational facilities across each tier of government, and the role of private landowners overseeing a significant proportion of green space, presents challenges for a coherent approach. Even within levels of government, coordination between sectors can result in reduced access to facilities, such as a lack of adequate transport connections to sporting precincts and stadiums. Fragmentation also creates challenges in collating consistent data with which to draw out state or national trends in the quality of and access to green, blue and recreation infrastructure across Australia. There is no consistent approach to data capture across jurisdictions to understand current use and feedback on what is working well and what needs to be improved.



112. Challenge

Fragmented governance of green, blue and recreation infrastructure makes it hard to integrate into land-use planning. Without action, a lack of coordination for both planning and data could lead to a loss of critical green, blue and recreation infrastructure and inefficient use of existing spaces and facilities.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



New green, blue and recreation infrastructure is expensive to acquire and maintain

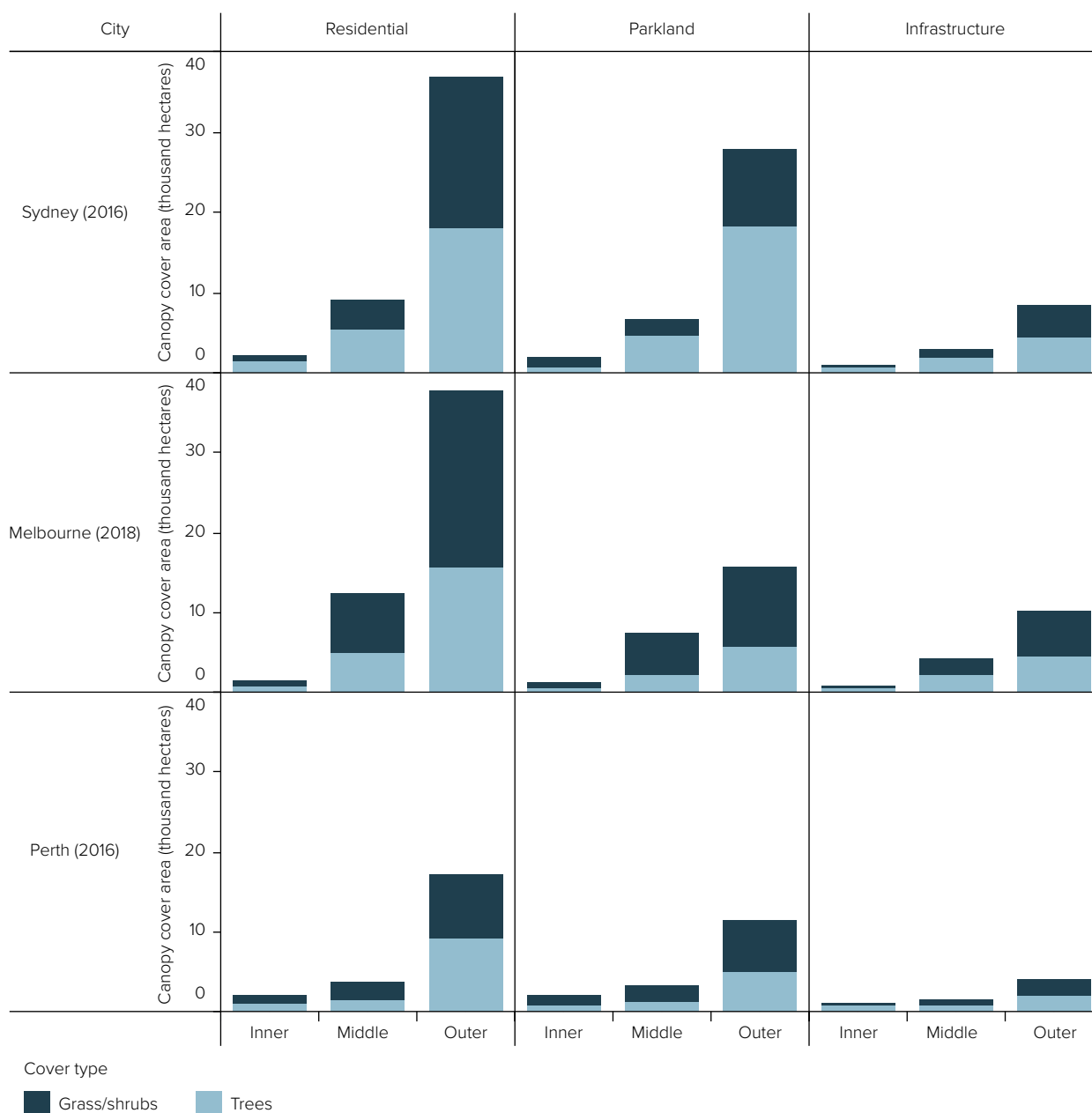
Population growth and densification is placing pressure on existing green infrastructure in our fast-growing cities. In most areas, these spaces and facilities are highly valued and overused.

Figure 8, which shows the amount of land cover from vegetation in three of Australia's largest four cities, demonstrates the lower levels of provision of both private and public green space in the inner and middle suburbs of Sydney and Melbourne. The majority of green space in these cities is private residential (such as backyards). As these cities grow and densify, this space will reduce as demand for space for homes and businesses, particularly in inner areas, increases. This will impact the overall canopy cover for communities and reduce the immediate and long-term liveability benefits it brings. Canopy cover provides shade and urban vegetation that can reflect rather than absorb the sun's heat. In recognition of its contribution, many governments have recommended targets for increasing canopy cover.²¹³

Communities living in higher-density areas will therefore increasingly need to rely on shared, public green infrastructure, such as public parks. Higher-density buildings can also trap heat which contributes to the urban heat island effect. On the outskirts of our cities, problems can arise when the provision of green infrastructure, including water-sensitive urban design, is not properly incorporated into the master planning of new suburbs.

Managing the growth of these cities also means increasing the provision of infrastructure. An impediment is that land is expensive to acquire, particularly in the inner suburbs of our fast-growing cities where demand is most acute. These types of infrastructure also require large areas of land – for example for recreation facilities like sporting fields or stadiums, community centres, and for large parks or walking tracks.

Figure 8: The majority of canopy cover in Sydney, Melbourne and Perth is located in outer-metropolitan residential areas



Note: Residential and parkland land use classifications are derived from ABS Mesh Block areas.²¹⁴ Infrastructure refers to land occupied by streets and roads. Inner-, middle- and outer-urban boundary definitions were those used in *Outer Urban Public Transport*,²¹⁵ however the extent of the outer-urban boundary was adjusted to align to each city's urbanised land boundary, using ABS Urban Centres and Localities.²¹⁶

Source: Infrastructure Australia analysis of unpublished data (The Clean Air and Urban Landscapes Hub, 2018)²¹⁷

There is an even greater challenge for blue infrastructure, as there is limited ability to 'build' new spaces for water, such as rivers, harbours or beaches as they are existing features of the landscape. In this case, protection of these sites, rather than acquisition of new assets, is the usual approach. In different jurisdictions in Australia and overseas, best practice open-space policy increasingly requires land acquisition and dedication through development processes to establish adequate, accessible public space.

Considering the breadth of green infrastructure in the design of places is important in enabling people

to connect with the natural environment and support a range of ecosystem services such as clean air, water and productive soils. Creating a network of green connections (for example, high-quality pedestrian or shared cycling and walking footpaths) provide opportunities for a series of individual small projects to deliver a large-scale impact when woven together to form a new landscape across an urban area.²¹⁸ In urban environments, where green, blue and recreation infrastructure may be challenging to deliver in large quantities, the quality of these spaces become important. The provision of smaller, high-quality parks has been positively linked to stress relief and social cohesion.²¹⁹



Councils in fast-growing cities, such as Gosnells on the urban fringe in Perth or Ryde in the middle band of Sydney, have acquired land to increase the availability of public green space. Major urban renewal projects like the 480-hectare Fishermans Bend precinct in Melbourne are also incorporating public-space strategies that require mandatory contributions for open space and plan in advance for future population growth and settlement. This forward planning recognises the long-term social, economic and environmental benefits that are anticipated from these investments, and are more expensive to retrofit in the future. It is estimated that the total cost of acquiring and improving open space for Fishermans Bend is \$1.5 billion (in 2016 dollars).²²⁰ However, this investment is planned to support a community built over the next thirty years providing an additional 80,000 residents and 80,000 jobs for Melbourne by 2050.²²¹

Increased demand for green infrastructure in both the inner and outer suburbs of our cities will have ongoing management and maintenance costs for government, particularly at the local level. For example, in recreation infrastructure, the increase in female participation in community sports has created challenges for some sporting assets to adequately upgrade changing rooms and toilet facilities. This is particularly the case for an increasing number of women and girls participating in Australian Rules football and Rugby Union.²²² The broader social benefits mean that equitable access to public spaces should continue. However, with increasing fiscal constraints on governments at all levels, it can be convenient to question the financial and economic

business case for green infrastructure. In this context it is important to properly value and prioritise the secondary benefits and externalities that support these investments for communities over the longer term.

Green and blue infrastructure does not present opportunities to generate direct economic benefits from a user-payers model, due to community expectations for free access to parks, sporting fields and beaches. The potential for increasing economic benefit are more likely where public space can be utilised for a range of purposes. Land which has traditionally been used for other purposes, such as private golf courses or memorial gardens, or restricted access in public schools, may provide new opportunities for expanded uses in fast-growing cities where new land is scarce and expensive acquire, through re-purposing or joint-use arrangements.

In smaller cities, regional centres, and rural communities and remote areas, there are different challenges in acquiring new green, blue and recreation infrastructure. Lower demand in these areas can make it difficult to sustain funding for maintenance, particularly for recreation infrastructure like sporting facilities or playground equipment. Spaces and facilities may also be dispersed across multiple sites, making it difficult to create efficiencies. While space constraints are not felt as acutely in these areas as they are in fast-growing cities, using limited funding for this type of infrastructure more efficiently into the future may require greater use of multi-use facilities and shared-use arrangements.

113. Challenge

In fast-growing cities, green, blue and recreation infrastructure is highly valued and overused. The high cost of land, operations and maintenance make it difficult to fund the delivery and maintenance of new infrastructure in these cities. Our fast-growing cities risk not having adequate high-quality, accessible green, blue and recreation infrastructure as they grow and densify, particularly in inner-urban areas.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



114. Challenge

In areas outside of fast-growing cities, green, blue and recreation infrastructure is often fragmented across multiple assets and expensive to maintain. Lower demand in these areas can make it difficult to fund the delivery, operations and maintenance of new infrastructure. High costs of maintenance for underused assets can create challenges in providing adequate high-quality green, blue and recreation infrastructure to support communities.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



The urban heat island effect will increasingly impact the liveability and resilience of our cities

Australia has warmed by more than 1°C since 1910, with most warming since 1950. This has increased the frequency of extreme heat events,²²³ having implications for the liveability, productivity, resilience and health of Australian cities. Australian cities are feeling the impact of this heat, due to the urban heat island effect.

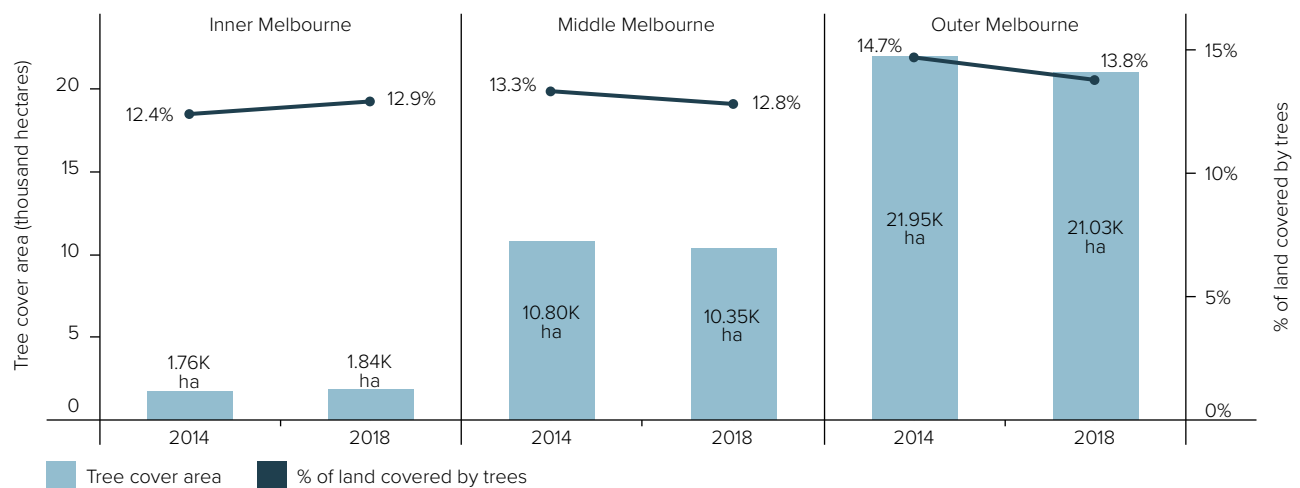
The urban heat island effect is a phenomenon where the air and surface temperatures of cities are typically much higher than surrounding rural or forest areas.²²⁴ This is because the heat of the sun is absorbed and not reflected by urban surfaces such as buildings, car parks and roads. Human activities, such as traffic and the use of air conditioning, also increase the waste heat generated. For example, the urban heat island effect has been found to create as much as a 6°C difference in temperature in Sydney.²²⁵

It also impacts infrastructure sectors including health, transport, and energy. Increased demand on the electricity network from air conditioning contributes to blackouts and increasing carbon dioxide emissions. Protecting and enhancing green infrastructure is one strategy to mitigate the impact of the urban heat island effect and support carbon storage.

The location and type of canopy cover can play an important role in mitigating the impacts of the urban heat island effect. Figure 9 shows the change in tree cover in Melbourne between 2011 and 2016. Tree cover has reduced slightly and the proportion of the city's cover located in outer suburbs is stark, indicating the majority of canopy cover is privately owned (in private residential backyards).



Figure 9: Canopy cover in Melbourne remained roughly the same between 2014 and 2018



Note: Inner-, middle- and outer-urban boundary definitions were those used in *Outer Urban Public Transport*,²²⁶ however the extent of the outer-urban boundary was adjusted to align to each city's urbanised land boundary, using ABS Urban Centres and Localities.²²⁷ Additionally, areas that were not present in both the 2014 and 2018 study extents were excluded, hence these results differ slightly from Figure 8.

Source: Infrastructure Australia analysis of unpublished data (The Clean Air and Urban Landscapes Hub, 2018)²²⁸

Cooling Darwin

Darwin has a hot and humid climate with a temperatures exceeding 30°C for almost 90% of the days of the year. The city's population growth has slowed recently, and creating a cooler city is integral to attracting more residents and visitors.

Green infrastructure is therefore a major focus of the Darwin City Deal (the Deal) which aims to transform the city centre into a cooler, greener public space. The Deal is part of the Australian Government's *Smart Cities Plan* and was developed in partnership with the Northern Territory Government, Darwin City Council and Charles Darwin University.

CSIRO will lead a Darwin Urban Living Lab that will use the latest science to test, monitor and evaluate improvements in Darwin's liveability, sustainability and resilience. The Urban Living Lab will test the effectiveness of heat mitigation measures delivered as part of the City Deal and develop evidence-based approaches to inform tropical urban design and future development in Darwin. The Deal will also support the trial of different initiatives which help to reduce surface and air temperatures in Darwin's CBD, for example, the Cavenagh Street shade structure.²²⁹

As our cities grow, poor urban design outcomes risk limiting opportunities for increasing canopy cover. This can arise through a reduction in lot sizes and backyard size (as development controls allow larger residential development, closer to boundaries), a reduction in the number of homes with backyards, and increasing population density in inner and middle suburbs where canopy cover is already much lower. In inner-city areas the management of above ground and subterranean infrastructure, associated planning controls, and pavement design can all impact on the ability to effectively improve canopy cover, often where it is most needed.

Nonetheless in all areas of our cities, the role of street trees will become more important over time in reducing footpath heat, air conditioning required for surrounding buildings, and enabling more comfortable walking environments. Additional benefits will flow from their contribution to green corridors and related ecosystems, and improved amenity and liveability associated with increased green space and biodiversity.

There is increasing recognition of the broad benefits and long-term value created through investment in blue and green infrastructure. The Greater Sydney Commission has prioritised the ‘Green Grid’ as ‘a long-term vision for a network of high-quality green areas – from regional parks to local parks and playgrounds – that connect centres, public transport and public spaces to green infrastructure and landscape features’ across Greater Sydney.²³⁰ The City of Melbourne Urban Forest Strategy aims to increase canopy cover from 22% to 40% by 2040 ‘to guide the transition of our landscape to one that is resilient, healthy and diverse, and that meets the needs of the community.’ Its intended outcomes are to create resilient landscapes, community health and wellbeing and a liveable, sustainable city.²³¹ These long-term visions and associated planning will require support through appropriate requirements for new plans, projects and development on the ground to ensure the stated targets are realised.

115. Challenge

Green canopy cover is increasingly hard to provide in cities as backyards decrease and densification occurs. Without action, access to green space will diminish in our cities, and liveability will increasingly be affected by the urban heat island effect.

**When this
will impact:**

0-5

5-10

10-15

15+

**Where this
will impact:**



Performance of arts and cultural infrastructure

Cost

85%

of the NSW creative community identify a **lack of affordable space** as a significant challenge ²³²



Quality

The quality of **arts and cultural infrastructure** is rated higher in urban areas than in rural and remote areas ²³³

Cost



Australian households spend **\$6.5 billion** a year on arts-related goods and services ²³⁵

Access

Australia's national cultural institutions had **have digitised over 1.1 million** objects by 2017-2018 ²³⁴



Cost

Quality

Australia's home to 19 world heritage listed sites: 12 natural, 3 cultural, 4 mixed ²³⁶



Private contributions

to the arts and culture sector are: **higher** than Canada, **similar** to England and **well below** that of the US ²³⁷



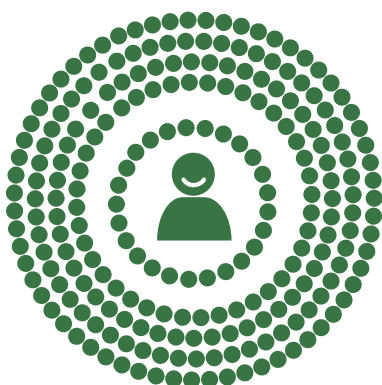
Access

1 in 3

First Nations people in remote Australia creatively participate in First Nations arts and almost

1 in 10

earn income from the arts ²³⁸



Access



76 of 79 local councils in Victoria manage at least one arts and cultural collection ²³⁹

Scale of arts and cultural infrastructure

Customer

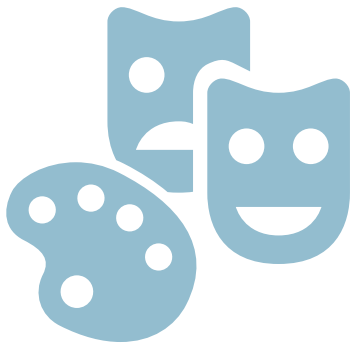
In 2017-18,

over 82%

of Australians attended at least one arts and cultural venue or event ²⁴⁰



Industry



Culture and creative sector contributed

\$111.7 billion

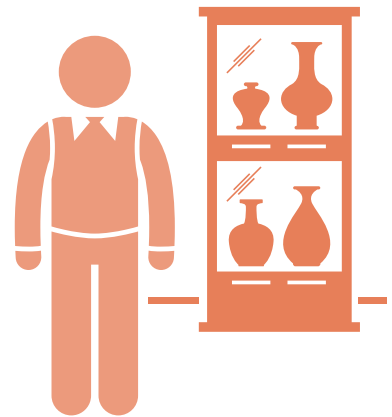
to Australia GDP in 2016-17 ²⁴²

Asset

National **collecting institutions** are custodians of over

\$8 billion

arts and cultural assets ²⁴¹



Customer

3 in every 10

international visitors to Australia in 2017 visited a museum or gallery ²⁴³

Industry

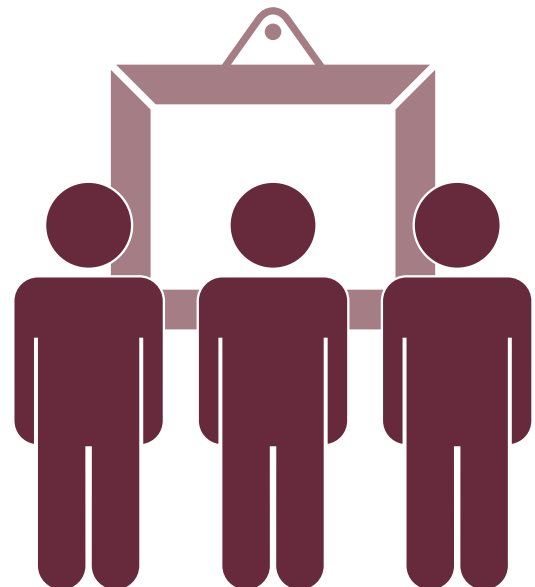


1 in 6

professional Australian artists live in regional cities or towns.

1 in 10

live in rural, remote or very remote areas ²⁴⁴





6.5 Arts and culture

Sector overview

Arts and cultural infrastructure promotes social cohesion in our communities by facilitating shared experiences, promoting a sense of place and providing insight into our local and national identities. It is the buildings and spaces that accommodate or support cultural activities, production and events. It can be owned and operated by local, state or federal government, as well as private and not-for-profit sectors. It includes:

- **Significant cultural institutions** such as museums, art galleries, theatres and performance spaces, such as the Sydney Opera House, Questacon, MONA, the National Library of Australia, or the Art Gallery of Western Australia.
- **Significant natural assets of cultural value** and their supporting infrastructure, such as Uluru in the Northern Territory.
- **Other small and large venues** such as theatres, art studios, festival spaces, public art programs, galleries, local libraries, live music venues and other spaces for art and cultural production, sometimes used in a temporary way.
- **Digital cultural infrastructure**, such as platforms providing access to online collections and performances.

This Audit discusses all types of arts and cultural infrastructure, with a particular focus on nationally-significant institutions and government-supported infrastructure.

At a glance

This section addresses the challenges we face in quantifying the value of arts and cultural infrastructure. We know Australians benefit greatly from these assets, but we lack the data to identify service gaps and integrate the sector in our strategic planning.

There is no one-size-fits-all approach to delivering and funding arts and cultural infrastructure. But these assets, though expensive, are crucial to strengthening society and empowering aboriginal and Torres Strait Islander communities. Digital technologies can help us increase access.

Quantifying the economic and social value of arts and cultural infrastructure is a challenge

Art and culture are a part of many Australians' lives – whether we attend exhibitions or events, or even just pass by public art in the street every day. In 2017-18, over 82% of Australians attended at least one arts and cultural venue or event, including arts galleries and museums, music performances and theatres.²⁴⁵ People living in cities and those on higher incomes are more likely to attend arts and cultural venues and events.²⁴⁶ Cinemas, live music performances and art galleries are the most frequently attended venues and events.²⁴⁷

The social benefits that Australia's arts and culture infrastructure sector delivers for communities are well understood. These benefits include contributing to quality of life, social cohesion, to our own individual and collective identities of Australia and what it means to be Australian, particularly in providing connections to our Aboriginal and Torres Strait Islander heritage. This sector also contributes to our national identity, on both a global and local scale, and attracts international visitors.

Arts and cultural infrastructure help us to preserve our heritage, through physical archives and artefacts, and through storytelling and performance, to better understand our cultural identity, learn from history and engage with other societies' histories. In this sense, it also contributes to learning and education – for both children and adults, about our past and present. Finally, arts and cultural infrastructure can play an important role in enhancing the liveability of places by activating spaces, such as public art programs in train stations or street performances.

While the benefits to Australians of high-quality, accessible and affordable arts and cultural infrastructure are significant, it can be difficult for governments to adequately quantify the contribution this sector makes to our social and economic wellbeing. Investment is often perceived as a pure cost, rather than an investment in community wellbeing. But the benefits of this sector are not solely social in nature. Australia's arts and cultural sector supports direct and indirect jobs and generates exports, contributing \$111.7 billion (or 6.4% of GDP) to the economy in 2016-17.²⁴⁸ It also plays an important role in supporting economic development in communities, particularly remote Aboriginal and Torres Strait Islander communities where arts and culture are

key sources of income and economic empowerment. Arts and culture can also help to improve the vitality of our night-time economies in fast-growing cities, generating economic activity and improving the liveability of these places. The sector also supports community benefits in other sectors such as transport, health, education, tourism and service industries through promoting innovation and creativity. Creativity and problem-solving skills will be increasingly important for future-proofing occupations to technologies such as machine learning and mobile robotics.²⁴⁹

While these social and economic benefits are acknowledged by governments and felt by communities, there are difficulties in quantifying them for the purposes of investment, often due to their interdependent and qualitative nature. Arts and cultural infrastructure is often not considered as essential social infrastructure – unlike hospitals, schools or fire stations. This can make it challenging for governments to prioritise capital investment in arts and culture, and to incorporate arts and culture into related infrastructure projects or broader government programs.

The Statistics Working Group of the Meeting of Cultural Ministers in April 2018 recognised this challenge and acknowledged that there is no universally accepted approach.²⁵⁰ However, attempts have been made, including an analysis of the social asset value of our most recognisable cultural icon, the Sydney Opera House, which estimated it to be worth \$6.2 billion in 2018, including \$1.2 billion in economic contribution.²⁵¹

Both Infrastructure New South Wales and Infrastructure Victoria have recommended a cultural infrastructure investment prioritisation framework,²⁵² and such frameworks have now been developed in some states. A better evidence base which maximises and leverages the social and economic benefits of arts and cultural infrastructure across government by informing proposal development, business case assessment and budget decision making to ensure all Australians can benefit from arts and cultural infrastructure.

Data on the scale and distribution of arts and cultural infrastructure is limited due to fragmented governance

Arts and cultural infrastructure are diverse in terms of scale, geography, attendees, ownership and management structures. These venues and spaces support many different creative disciplines including visual arts, performing arts, heritage, museums, archives and libraries. In addition, different communities have different arts and culture interests and preferences. As a result, investment in infrastructure is often unique and requires a nuanced understanding of local community needs.

While there were 44,000 practising professional artists in Australia in 2015, with 17% working full-time on creative practice,²⁵³ it is harder to determine the number of arts and culture organisations in Australia. The Register of Cultural Organisations captures organisations that are able to receive tax-deductible donations, and listed 1,813 organisations in February 2019.²⁵⁴ However, this is likely only a small proportion of the total number of cultural organisations across the country. A more indicative figure is likely to be the 40,800 'cultural organisations' in Australia estimated a decade ago in 2008-09, in addition to a further 57,800 people who were registered as a 'cultural business'.²⁵⁵

The Australian Government is responsible for the eight national collecting institutions, which includes assets such as the National Gallery of Australia and National Film and Sound Archive located in Canberra. Together, these eight institutions are the custodians of the 'national collection', valued at over \$8 billion and comprising around 13 million objects.²⁵⁶ These institutions attract over 10 million physical visitors each year, and reach a further 50 million people accessing their collections and programs through digital means.²⁵⁷ The Australian Government also contributes to managing some natural cultural assets, for example through the Uluru-Kata Tjuta National Park for the Uluru site and surrounding land in the Northern Territory.

116. Challenge

Investment in arts and cultural infrastructure is often not prioritised because the true costs and benefits are not well integrated into government decision making. Without action, arts and cultural infrastructure will not be delivered, reducing access for communities to spaces which enhance liveability, creativity and help to create a sense of identity.

When this will impact:



Where this will impact:



State and territory governments play a large role in the provision of cultural infrastructure, particularly in our capital cities, and in supporting our naturally-occurring cultural attractions. They are responsible for the ongoing operation and maintenance of state-significant institutions to prescribed standards in their respective jurisdictions, such as state libraries, art galleries and museums. They are responsible for supporting the access to and preservation of our natural cultural assets and their supporting facilities. States and territories also provide capital funding for one-off projects, often in addition to philanthropic donations. Most Australian states (Western Australia, New South Wales, Queensland, South Australia, Tasmania and the ACT) have developed arts and cultural strategies to guide grant funding and policy direction, but few (Western Australia, New South Wales and the ACT) have developed specific strategies to support planning and prioritise investment for cultural infrastructure.

Local governments also provide important spaces for art, including studio and rehearsal spaces, and play a crucial role supporting the health of the small to medium arts sector. For example, the City of Melbourne funds smaller contemporary galleries such as West Space in partnership with Creative Victoria and the Australia Council for the Arts.²⁵⁸ Bendigo Art Gallery, operated by the City of Greater Bendigo, is a major attraction for visitors. It receives over 300,000 visitors per year.²⁵⁹

Private business and not-for-profit organisations also provide arts and cultural infrastructure by owning, operating and managing concert venues, musical theatre, private galleries, cinemas, live music venues and supporting facilities for our natural cultural attractions. Examples of significant non-government venues include White Rabbit Gallery in Sydney, the Pro art Gallery in Broken Hill, the Margaret River Busselton Tourism Association (MRBTA) in Western Australia and the Museum of Old and New Art (MONA) in Tasmania, which is now the second-most visited tourism attraction in Tasmania with approximately 350,000 visitors in 2017.²⁶⁰

The fragmented governance arrangements for the arts and cultural infrastructure sector makes it difficult to quantify the number, location, capacity and constraints of existing facilities and venues, restricting the ability to properly assess and optimise these assets. The lack of consolidated, national data on existing infrastructure facilities limits our ability to determine gaps in the arts and culture infrastructure network. *Measuring the economic value of cultural and creative industries—Statistics Working Group of the Meeting of Cultural Ministers* (April 2018) analysed the nature of the sector's fragmentation and specifically identified the difficulty in generating consistent datasets across the arts and culture sector.²⁶¹

Embedding arts and culture into other sectors can deliver benefits to communities

It is a challenge to connect arts and cultural infrastructure with other infrastructure investments, such as education, health or transport. However, the potential benefits for communities when arts and culture are embedded at the strategic planning stage for land use plans, economic development strategies or infrastructure strategies and projects can be significant. In many instances, arts and cultural aspects are a late add-on to beautify an infrastructure project or precinct, rather than being a part of the vision from the beginning. This is generally because arts and cultural infrastructure does not serve a functional purpose in the way that health or education assets do, despite the significant benefits it can deliver. However, there is an increasing number of examples where art and cultural infrastructure is being successfully embedded into broader infrastructure project planning.

Public art is reimagining public spaces for civic purposes, and art that celebrates stories of place can provide opportunities for multiple voices to reflect on history and the future of places to shape their evolution. For example, the River Studios in Melbourne is a converted warehouse of studios for arts practitioners operating under a commercial arrangement as part of the Victorian Creative Spaces program.²⁶² The project was developed as a partnership between local government, state government and the owner of the building.

117. Challenge

Governance of arts and cultural infrastructure is fragmented, resulting in a lack of comprehensive data on the scale and distribution of the sector. Without action, investment in the sector will not be prioritised, leading to poorer accessibility and quality arts and culture infrastructure for communities.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:





Cultural infrastructure has also been secured through land-use planning mechanisms, including zoning incentives and developer contributions. These mechanisms provide additional incentives for non-government providers to engage with the sector and support its development. Philanthropy can also play a role in enabling capital investment in cultural infrastructure, for example, the redevelopment of the Art Gallery of New South Wales, termed Sydney Modern, includes \$100 million of private investment.²⁶³

Embedding art into public transport infrastructure

INTERLOOP was installed in December 2017 as part of a \$100 million renewal and redevelopment program of Wynyard Station in Sydney's CBD.

The installation provides a visual reminder of the station's social and architectural history. It repurposes heritage wooden escalators into a vast twisting accordion-shaped sculpture above modern escalators. First installed in 1931, the historic timber-escalators served Sydney's commuters for over eight decades before they were removed in 2017.

Suspended between two ends of the building, INTERLOOP measures more than 50 metres in length, weighs over five tonnes, and weaves in 244 wooden treads and four combs from the original escalators.²⁶⁴

There is no one-size-fits-all approach to planning for arts and cultural infrastructure

In addition to the fragmented nature of the sector, there is also a geographical dimension to the provision of arts and cultural infrastructure. Most major cultural institutions are in the city centres of our state and territory capitals, while most of our natural cultural attractions are located outside of metropolitan areas. Access to arts and cultural infrastructure, particularly large-scale institutions, remains highest in the inner areas of fast-growing and smaller cities.

Cultural facilities and assets in outer areas of fast-growing cities, smaller towns and regional centres have different audiences and demand levels than urban areas. They are also more likely to be operated by volunteers, not-for-profit organisations and councils, meaning there are capacity and resourcing constraints in maintaining the facilities. Different communities have different needs and interests, and some arts and cultural activities have their own unique infrastructure requirements.²⁶⁵ As a result, it is difficult to apply a uniform approach to infrastructure planning, development and redevelopment in these communities.

Smaller cities and regional centres often have a lack of facilities of adequate size and flexibility to accommodate events and exhibitions, such as travelling opera or ballet performances, or regional tours for major exhibitions. In regional and rural communities, arts and cultural facilities often function as a central hub for other community activities and are a source of employment, meaning they need to respond to local needs and be well-connected to other types of infrastructure.



118. Opportunity

Well-integrated arts and cultural infrastructure can enhance the value of other types of infrastructure, such as public transport or green infrastructure. Leveraging investment across other sectors by embedding arts and culture into land use and infrastructure planning will provide greater benefits to communities to access arts and cultural infrastructure.

When this will impact:



Where this will impact:



East Pilbara Arts Centre, Western Australia

The East Pilbara Arts Centre was opened in 2016. It plays a key role in the identity and economic development of Newman, Western Australia. The centre was developed in partnership with the local Aboriginal Martu community, to ensure it creates a space for all and supports the local Martumili Artists group.

The Centre is designed to foster a sense of ownership among the people of the East Pilbara and link the community through events, exhibitions, learning and engage the whole community in active participation in the arts. The facility's spaces include a gallery, art storage spaces, a studio for artist development, a commercial kitchen and separate kitchenette, laundry, pump and camp storage room, office space and a caretakers' residence. There is also a large open area available for events and functions.

Funding for the facility was provided by the private sector, the Pilbara Development Commission, Lotterywest and the Shire of East Pilbara.²⁶⁶

One of the major challenges that emerges from the diversity of scale in the sector is a lack of affordable space for cultural production and performance, particularly in the small to medium sector. Arts practitioners across the country face difficulty in finding affordable spaces to work and many emerging and early career artists do not have the revenue base to support venue hire.²⁶⁷

The role of libraries is also undergoing a transformation, particularly in response to changing technologies and the changing nature of work.

Libraries are and will continue to be a place for people to learn, share and explore new ideas, whatever their stage of life. However many local libraries are creating new spaces for more adaptable uses, such as community or meeting spaces and performance spaces, and providing services like free Wi-Fi, multimedia services, business support and networking opportunities, which can be useful for remote working, entrepreneurs and start-ups. In regional, rural and remote communities, libraries can often be the focal point for cultural and social life, and can activate urban spaces and support inclusive participation for members of different communities.²⁶⁸

In the case of natural assets and their supporting infrastructure, location is often fixed and requires a bespoke infrastructure response. This is usually undertaken in partnership with relevant governments and communities, including local Aboriginal and Torres Strait Islander communities. Provision of amenities and connections to other infrastructure is often important in the case of tourist attractions and Aboriginal and Torres Strait Islander heritage assets to ensure the sites are accessible and supported in a way that is respectful to local people and cultures.

For example, the Mossman Gorge Centre was built at the entrance to the Mossman Gorge World Heritage Site in Queensland, the traditional homeland of the Kuku Yalanji people, in response to the increasing issue of tourist traffic through the local community and into the Gorge, which was compromising the sustainability of the site and future access. The centre is the final point tourists can reach by car, after which they board a low-emission shuttle bus operated by the centre to proceed further into the Gorge. The Centre has an Aboriginal employment rate of approximately 90%, most of whom are local Kuku Yalanji people, who share their stories and knowledge of the area with visitors. It also includes an art gallery showcasing the work of Kuku Yalanji artists, retail stores and a café.²⁶⁹

119. Challenge

The arts and cultural infrastructure sector varies across Australia, making it hard to address local needs, audiences, demand levels and funding. Traditional approaches to planning, delivering and maintaining arts and cultural institutions and programs do not always respond to local needs, requiring new approaches to improve access and quality for local communities and visitors.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Maintaining arts and cultural infrastructure assets is a challenge

Similar to other infrastructure, arts and cultural assets can be expensive to build and maintain.²⁷⁰ However, arts and cultural assets often require unique spaces (such as large-scale spaces or flexibly designed spaces), conditions (such as specific temperatures to preserve artefacts), and equipment (such as lighting and sound).

There are significant maintenance backlogs within arts and cultural infrastructure across the country, and insufficient storage for growing collections. These issues present an ongoing challenge that could compromise user experience, service quality and access. Scheduled maintenance is often critical to preserve the value of collections and the integrity of the assets, while also meeting workplace health and safety standards. Many of the major cultural infrastructure assets are iconic, heritage buildings with high maintenance requirements, or naturally occurring assets that require significant preservation efforts. It is also difficult to re-purpose venues that were not originally designed to meet changing demands for interactive cultural experiences or new visitor requirements, and provide access to natural assets in locations that are hard to reach.

In addition to maintenance challenges, collecting institutions such as galleries and museums, are further constrained by space to both display and store their valuable collections. The size and value of public arts and culture collections across Australia is significant. For example the national collecting institutions house around 13 million objects valued at over \$8 billion,²⁷¹ and the New South Wales Government's collections were valued at \$8.2 billion in 2016.²⁷²

However, a high proportion of collections are not on public display, largely due to space constraints. The National Gallery of Australia (our largest collecting institution) has display space for around 2% of its \$6 billion collection.²⁷³ The Art Gallery of Western Australia displays around 5% of its collection each year.²⁷⁴ This restricts access for communities to the collections these institutions hold, and places a premium on good storage and accessibility. Institutions in heritage buildings often have limited scope for expansion due to constrained sites and higher capital costs to meet heritage requirements. The Art Gallery of Western Australia has identified a need to almost double its storage space capacity to meet its needs through to 2032, and it has already converted some exhibit space to storage space.²⁷⁵

The collections, back of house activities and the expertise of staff contribute to the wealth of the facilities themselves. Some institutions are beginning to make wider collections and staff activity more visible to the public through 'behind the scenes tours', showcasing stories of staff members at arts and cultural institutions or removing physical barriers within institutions themselves to enable the public to gain a view to these parts of the institutions. For example, the Museums Discovery Centre in Sydney is the storage facility of the Museum of Applied Arts and Science, Australian Museum and Sydney Living Museum. In 2016, the Centre was opened to the public, providing access to a much larger proportion of the collections, and in a new environment.²⁷⁶

Storage capacity and display space are also under pressure due to the growth in collections, especially for cultural institutions like libraries and museums that receive personal legacies. Historically, storage facilities were located inside major institutions. However, on-site storage facilities no longer have the capacity to accommodate public collections.²⁷⁷ Storage facilities also house other collections, particularly those in the hands of local government. In Victoria, 76 out of 79 councils manage at least one collection, with most having public art and local history collections. While digital infrastructure is an opportunity to improve public access to collections, it may not reduce pressure on display and storage space unless collections are reduced once digitised. At the same time, digitisation and curation of online collections requires significant resources to establish and maintain.

The maintenance and storage collection challenges facing arts and cultural infrastructure highlights a broader challenge of investment levels in the sector. As governments continue to face fiscal constraints, models that generate revenue to cover the long-term operating costs of arts and cultural infrastructure are becoming increasingly common. The Museum of Contemporary Art (MCA) in Sydney is a model for financial self-sufficiency and co-funding for new infrastructure. A \$55 million redevelopment in 2012 was jointly funded by all levels of government and private donors. The new five-storey wing increased the total size of the MCA by almost 50%, and introduced revenue-generating activities such as rooftop venues and spaces for hire, an expanded MCA Store and commercial offices. In 2017, 74.2% of the MCA's total income was raised from non-government sources.²⁷⁸

Many cultural institutions have incorporated commercial activities into their operations to provide additional revenue and activate spaces. These additional activities have an impact on building space and design, and feed into capital investment decisions.

120. Challenge

Arts and cultural infrastructure suffers from maintenance backlogs, high costs of heritage maintenance, and space constraints, resulting in assets not being fit-for-purpose. Without appropriate long term planning and funding prioritisation, the quality and accessibility of these institutions for users will diminish.

When this will impact:

0-55-1010-1515+

Where this will impact:

Australia map icon

City icon

Heritage icon

Arts icon

Performance icon

Icon: Hand holding people

Icon: Target

Art and culture play an important role in empowering Aboriginal and Torres Strait Islander communities

For more than 65,000 years, intensive artistic activities have been a core feature of Aboriginal and Torres Strait Islander cultures and communities. Arts and cultural participation supports cultural identity, economic empowerment, community connectedness and wellbeing among these communities.²⁷⁹ This can help improve outcomes for Aboriginal and Torres Strait Islander people, including economic and social wellbeing, and connection to culture and country, which the Australian Government has committed to as priorities.

Cultural infrastructure can support meaningful economic empowerment and employment opportunities by providing the spaces needed to create and promote Aboriginal and Torres Strait arts and culture. This is especially relevant as research shows a continuing domestic and international demand for authentic Aboriginal and Torres Strait Islander art, culture and tourism experiences.

Arts and culture plays a particularly important role in remote communities, as evidenced by participation levels shown in Figure 10. In 2017, one in three Aboriginal and Torres Strait Islander people living in remote areas participated in First Nations arts, and almost one in ten earned income from it.²⁸⁰ In many of these communities, arts production is the main source of commercial income.²⁸¹

Figure 10: Aboriginal and Torres Strait Islander participation in economic arts activities is greatest in remote areas

Activity	Major cities	Regional	Remote
Sale of painting and art works	1.2%	1.5%	6.7%
Sale of other arts and crafts	0.6%	0.6%	2.6%
Arranging or participating in cultural dancing or performances	1.7%	1.6%	1.6%
Economic arts participation total	2.8%	2.9%	8.8%

Source: Australia Council (2017)²⁸²

447

Executive summaryIntroductionFuture trendsUsersIndustryTransportSocial infrastructureEnergyTelecommunicationsWaterNext steps

Infrastructure, such as remote Indigenous Art Centres, are crucial to facilitating this cultural participation and promoting economic empowerment. Remote Indigenous Art Centres generated around \$53 million in art sales between 2008 and 2012, with \$30 million paid to artists. Around 40% of art sales were reinvested in art centres, which often acts as activity hubs in small communities, providing meeting, and kitchen and bathroom facilities.²⁸³ However, many of these facilities are no longer fit-for-purpose and suffer from poor maintenance. This infrastructure gap is present at both small and large scales.

The art emerging from the various schools of Aboriginal and Torres Strait Islander artists has received global recognition for its unique aesthetics, power and cultural significance. While a large proportion of overseas visitors seek to view Aboriginal and Torres Strait Islander art, collections are often spread across multiple major institutions. This fragmentation reduces the impact of major collections. There is no dedicated national Aboriginal and Torres Strait Islander arts and cultural centre or collecting institution in Australia.

The United States of America opened the Smithsonian's National Museum of the American Indian in 2004, though it took many years to establish following an initial Act of Congress in 1989. This example shows that national-scale cultural infrastructure, particularly one that is dedicated to a subject as important as the heritage of First Australians, takes long term commitment, partnership and resources.

Steps have been made across jurisdictions to establish institutions for Aboriginal and Torres Strait Islander arts and culture in Australia, including Infrastructure New South Wales recommending a flagship Indigenous Cultural Centre in 2014, and a similar approach proposed for Alice

Springs in the Northern Territory.²⁸⁴ The South Australian Government is including an Australian National Aboriginal Art and Culture Gallery and a contemporary art space in its renewal of the old Royal Adelaide Hospital site.²⁸⁵ This progress will support further participation and empowerment for Aboriginal and Torres Strait Islander peoples in arts and culture across Australia.

National Museum of the American Indian

The Smithsonian's National Museum of the American Indian demonstrates the time and commitment required to establish a new cultural infrastructure asset that is dedicated to indigenous heritage and history.

It is the first national museum in the United States of America dedicated exclusively to Native Americans. It includes the National Museum of the American Indian on the National Mall in Washington D.C., the George Gustav Heye Center, a permanent museum in Manhattan, New York, and the Cultural Resources Center, a research and collections facility in Suitland, Maryland.

This museum was 15 years in the making, from an initial Act of Congress in 1989 to opening its doors to the public in 2004. Beginning in the early 1990s, the Museum opened dialogues with Native American communities and individuals across the Western Hemisphere. These early meetings were crucial to build support for the museum and understand how to appropriately incorporate Native American sensibilities throughout the design of the museum building.²⁸⁶



121. Opportunity

Arts and cultural infrastructure plays a key role in the social and economic empowerment of Aboriginal and Torres Strait Islander peoples. Leveraging investment in arts and cultural institutions to promote the collection and celebration of Aboriginal and Torres Strait Islander arts and cultural materials can provide wider socio-economic benefits to these communities, particularly in rural and remote areas.

**When this
will impact:**

0-5

5-10

10-15

15+

**Where this
will impact:**



Digital infrastructure can increase access to the arts and culture

The physical nature of much of our traditional arts and cultural infrastructure, such as galleries and museums, means they are limited to particular locations and places.²⁸⁷ This can restrict access for some users, for example a person in Sydney must travel a long distance to visit the East Pilbara Arts Centre in the north west of Western Australia.

Digital technology and telecommunications infrastructure are enabling the digitisation, preservation, conservation, interpretation and sharing of arts and cultural collections and material to broader audiences across Australia and the world. For example, the European Union established the Europeana Collections, which brings together over 58 million artefacts from European arts and cultural institutions through a publicly accessible online portal.²⁸⁸ Nationally, the Trove Platform operated by the National Library of Australia allows the public to view collections from hundreds of cultural and research institutions around Australia online. The Australian War Memorial has also launched a series of immersive digital experiences that will allow users to explore the workings of tanks and other vehicles in the Memorial's collection.²⁸⁹ Digital technology can also enable partnerships between cultural institutions such as the Victorian Culture Network (VCN) which is a collaboration between five arts agencies (Arts Centre Melbourne, Australian Centre for the Moving Image, Museums Victoria, National Gallery of Victoria and State Library of Victoria). It is delivering digital collection preservation and access initiatives for those agencies, as well as small to medium metropolitan and regional collecting organisations across Victoria.²⁹⁰

Digitisation of collections also presents an opportunity to deal with the challenge of growing the size of collections, but also provides valuable resources for researchers, enhances people's access to art and culture and has a role to play in keeping

Aboriginal and Torres Strait Islander languages and customs alive. Australia's peak representative body for galleries, libraries, archives, historical societies and museums sectors (GLAM) has recently undertaken a two year project funded by the Australian Government through Catalyst to develop a toolkit to assist smaller collecting institutions to digitise their collections.²⁹¹ The National Gallery of Victoria displays around 90% of its collection on its website.²⁹²

Regional and remote communities can benefit substantially from digital infrastructure in the arts and culture sector. However, challenges in providing physical internet connections and hardware and ensuring a sufficient level of online access and training in how to use relevant platforms, have been a significant barrier to online engagement. This limits access to online collections and the ability to share local collections and materials digitally.²⁹³

Digital technology offers an exciting opportunity to not only increase access to arts and cultural infrastructure but also opens up new ways to engage, participate and create in the arts. It is also changing the way arts organisation function especially in audience engagement, operations, archival work and marketing.²⁹⁴ Robust data analysis enables institutions to better respond to audience taste and behaviours or create user-generated content.²⁹⁵ Creative use of digital technologies could be applied in other sectors to support learning, social inclusion, health and wellbeing,²⁹⁶ and enable the creative sector to increase the economic impact of the arts.

Prioritising investment in digital technology within the arts and cultural infrastructure sector is occurring. However, as the use of digital technology has increased across the sector, government and non-government organisations are becoming more aware of the ongoing operational costs and diversity of skills required to support digital infrastructure assets. For example, online digital collections will still require ongoing curation if users are to receive the same quality experience they would from a physical visit.

122. Opportunity

Digital technology offers new ways to access arts and cultural infrastructure, beyond physical assets.

Harnessing technological advances and investing in ongoing maintenance and curation will improve accessibility to Australia's arts and cultural infrastructure, particularly for rural and remote communities located long distances from major institutions.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Performance of social housing infrastructure

Access

Between 2006 and 2016, homelessness has increased by

11 people per every 10,000

in major cities ²⁹⁷

Quality

Over one third

of remote housing is **overcrowded** ²⁹⁸



Quality



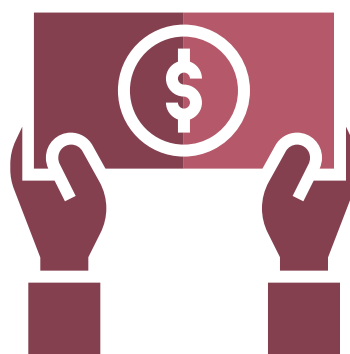
1/4 of Australians

rate social and public housing as **poor quality**, and likely to **worsen** ³⁰⁰

Cost

Lowest income quintile households spend

28% of their income ²⁹⁹



Cost



On average **each social housing dwelling** needs around

\$13,000

each year as a government subsidy to address funding gap ³⁰¹

Access



Public housing is viewed as the **least accessible** form of social infrastructure with

1 in 3

rating it as difficult to access ³⁰²



Other

11% of Australian households

were classified as being in **housing stress** in 2017 ³⁰³



Scale of social housing infrastructure

Customer

In 2017

50 people in every 10,000

were considered homeless ³⁰⁴



Asset

4.4%

of **Australia's housing stock** is **social housing**, compared to around **17% in the UK** and less than **1% in the US** ³⁰⁵

Industry

Crisis accommodation industry receives

\$3 billion in revenue

each year, with more than 780 providers

serving 105,000 homeless Australians ³⁰⁶

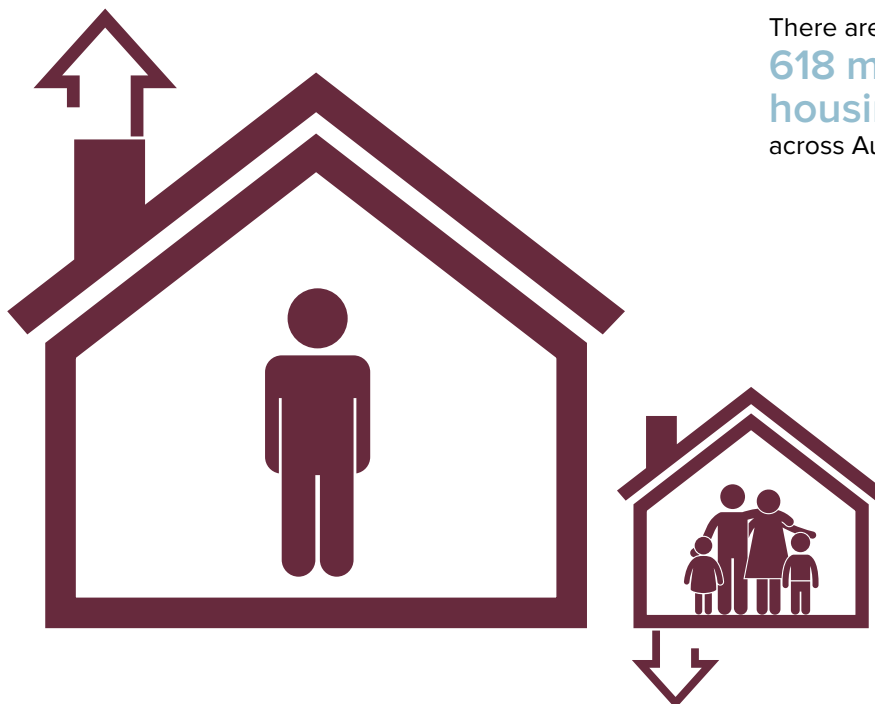


Industry

There are currently around

618 mainstream community housing organisations

across Australia ³⁰⁷



Customer

Couples with children have fallen from making up **70% of public housing households** in 1970 to just **4% today**, while single person households **have grown to 60% of households today** ³⁰⁸

Scale – by state and territory



Number of public housing dwellings



Number of state owned and managed Indigenous housing stock



Number of properties owned or operated by community housing providers

Note: Community housing is a combination of community-owned-and-managed, and publicly-owned, and community managed housing.
a. Public data unavailable.

Source: Based on EY analysis for Infrastructure Australia and supplementary engagement with relevant jurisdictions.

6.6 Social housing

Sector overview

Housing in Australia is generally delivered by the private market. However, there is a continuum of housing types, some of which are delivered by governments and not-for-profit partners. Types of housing in Australia include:

- **Crisis accommodation** refers to specialty housing for people who are homeless (do not have adequate living arrangements and do not have any alternative)³⁰⁹ or who require emergency accommodation. Crisis accommodation includes crisis shelters and hostels, women's and youth refuges and other emergency accommodation services.³¹⁰ It is short-term and generally provided by charities and not-for-profit organisations. Some funding for homelessness services, including the provision of crisis accommodation, is provided by state and federal governments.
- **Social housing** is an umbrella term for Australia's system of publicly subsidised housing provided to eligible households, usually on low to very low incomes. Social housing includes a range of dwellings subsidised by state and federal governments, owned and managed by the public sector and/or the community sector and/or other non-government providers. Responsibility for planning, delivering and managing social housing sits at the state government level, supported by federal and local government funding. It includes:
 - **Public housing** refers to dwellings owned (or leased) and managed by state and territory housing authorities.³¹¹
 - **Community housing** refers to subsidised housing managed by not for profit organisations which can be privately or publicly owned. Community housing providers (CHPs) can access Commonwealth Rent Assistance for additional revenue.
 - **Aboriginal and Torres Strait Islander housing** refers to social housing provided specifically for Aboriginal and Torres Strait Islander tenants, and can be located in urban, regional or remote areas. This housing is managed by state and territory governments. The majority of Australia's remote Aboriginal and Torres Strait Islander housing is located in Northern Australia, across Western Australia, the Northern Territory and Queensland.
- **Affordable rental housing** refers to housing provided at a subsidised rate (usually around 80% of market prices) to households on very low to moderate incomes. Eligibility criteria differ across jurisdictions, but aim to support those households that are unable to secure adequate and affordable rental housing in the private market.³¹² It is generally owned, managed and maintained by CHPs.
- **The private housing market** (including both rental and ownership) refers to housing, which is wholly paid for by individuals, at market prices. Dwellings are delivered by the private development sector. Private ownership can be outright or with a mortgage (owed to a lending institution). Across Australia in 2017, 67.5% of households either owned or were purchasing their own home and 25.1% were renting privately.³¹³ Government assistance can be provided to support those living in private market housing (for example, through first home buyers' grants or rental assistance).

This Audit focuses specifically on social housing infrastructure, in the context of its relationship to other types of housing along the housing continuum.

At a glance

Our housing system is a continuum that runs from crisis accommodation up to private ownership, but there are challenges in moving between different types of housing, particularly for households on low to very low incomes.

This section reviews the issues facing our social housing, such as long waitlists, ageing stock and poor maintenance. It highlights the impact of these issues for overcrowding in housing for Aboriginal and Torres Strait Islander communities in remote areas.

Social housing as infrastructure

Access to safe, adequate and affordable housing is a crucial foundation for enabling a person's physical and mental health and wellbeing. Without access to appropriate housing, people are unable to focus on other aspects of their lives (such as health, education and employment) and are unable to contribute productively to society. While housing is generally provided and sought in the private market in Australia, there are some people who cannot access housing in the private market. Many Australians may require housing assistance at some point in their life.

Social housing is an important piece of social infrastructure in Australia that serves both a social and economic purpose and contributes to the effective functioning of society. Social housing is a system of housing assets that provides homes at below-market prices to close to 400,000 households across Australia.³¹⁴ Similar to other types of social infrastructure, social housing is a long-term, asset-based, services-enabling piece of infrastructure.³¹⁵ It is a type of social infrastructure that improves the social and economic wellbeing of the people that use it by providing them with a safe, adequate and affordable homes.

There is an interconnected and interdependent housing continuum

Social housing is an important piece of a broader housing continuum in Australia. At one end of the continuum, people are experiencing homelessness and are in urgent need of crisis accommodation and, at the other, people own their own home outright. Each section of the housing continuum has interdependencies with the rest of the continuum, which means that gaps or pressures in one part of the housing market can impact the rest of the system. A lack of appropriate housing options for different income brackets can push people to the lower end of the housing market, resulting in more people needing housing assistance.

The use of a continuum illustrates the interconnectedness between different housing types and that these different segments of the housing market do not operate in isolation.³¹⁶ If supply does not meet demand at any point in the continuum, it

leads to poor outcomes for people, which can include living in overcrowded conditions and struggling to pay the rent or mortgage. Figure 11 shows this continuum of housing in Australia and where each housing type sits in relation to each other.

Ease of access to private market housing, particularly in major cities, has an impact across the continuum. A lack of housing supply has the potential to increase both rents and house prices. This can place households into housing stress, creating pressure further down the continuum. Housing stress can be defined in a number of different ways. The most common indicator used is the '30:40 indicator' where a household is identified as being in housing stress if its (generally disposable, rather than gross) income is in the bottom 40% of Australia's household income distribution and it pays more than 30% of that income on housing costs.³¹⁷

Despite a recent downturn in housing costs across Australia, rates of housing stress have increased over the past decade, particularly in our cities.³¹⁸ Increasing rates of housing stress means more people are not able to enter the private housing market (particularly younger generations) and so are more likely to stay at home longer, be forced to live in overcrowded or unstable accommodation, or slip into homelessness.

High costs and high demand at the top of the system places downward pressure on all other sections of the housing continuum. As more people are unable to obtain home ownership, they will seek private rental accommodation, pushing the lower end of the private rental market into housing vulnerability. When people slip out of the private rental market they require some kind of housing assistance, whether that is in the form of affordable housing, rent support, social housing or crisis accommodation.

If one section of the continuum is not functioning appropriately, this creates gaps that lead to greater pressure on other parts of the system. For example, in Australia there is a lack of affordable rental housing due to limited investment by governments in this type of housing, meaning households struggle to afford private market prices, or must wait, if eligible, for social housing. At the lowest end of the housing continuum is crisis accommodation, which provides temporary housing for people experiencing homelessness and in urgent need of assistance.

Figure 11: There is an interrelated continuum of housing types in Australia



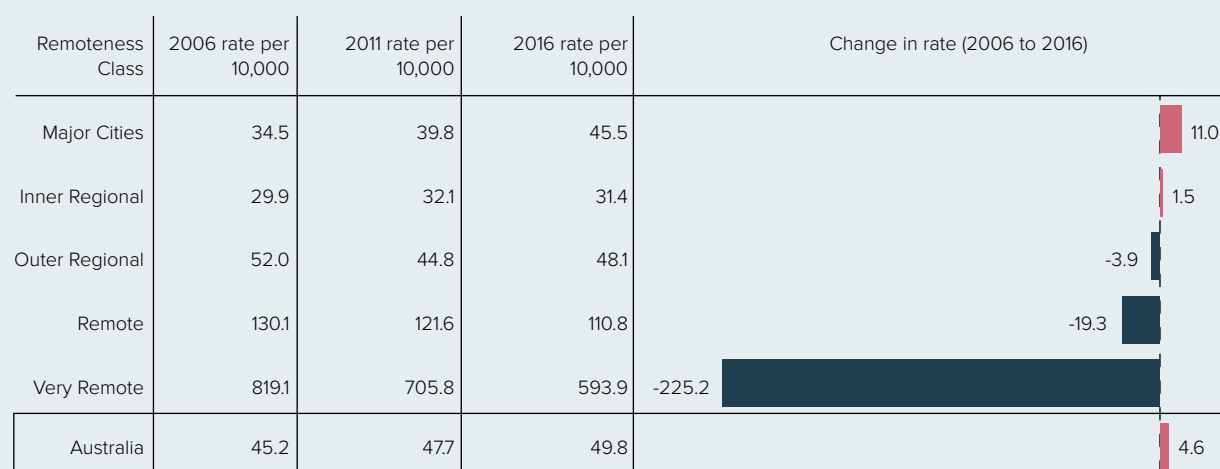
Homelessness and crisis accommodation in Australia

In 2016, there were approximately 116,427 Australians (or 50 people in every 10,000 people) who were considered homeless.³¹⁹ Crisis accommodation seeks to serve the most acute housing needs, where other options are not available, and is short-term in nature. One-quarter of these reported mental health issues and one-quarter identified as an Aboriginal or Torres Strait Islander person.³²⁰ In 2017–18, almost 288,800 people were assisted by specialist homelessness services across Australia, equating to 117.4 people per 10,000 population. There were also 86,100 unmet requests, of which almost 3 in 4 were seeking accommodation assistance.³²¹ The most acute need is for homeless Australians to access crisis accommodation.

Over time, total homelessness has increased across Australia, with the most notable increases between 2006 and 2016 having occurred in our major cities (see Figure 12). While significant decreases in rates of homelessness have occurred in remote areas, the highest homelessness rate (at SA4 level) in 2016 was in *Northern Territory – Outback*. High rates of homelessness in remote areas of Northern Australia can be linked to challenges in providing adequate remote housing for these communities.

Demographically, more vulnerable groups, such as those with disability, people suffering from health issues (particularly mental health, and drug and alcohol addiction), Aboriginal and Torres Strait Islander peoples, young people, and those having experienced domestic or family violence, and those exiting custodial settings (including correctional facilities, youth justice detention centres and immigration detention centres) are more at risk of becoming homeless or requiring homelessness services.³²² Prevalence of homelessness for these groups means homelessness support services need to work closely with other support services, such as health and justice.

Figure 12: Homelessness is increasing in major cities and decreasing in outer regional and remote areas



Source: Australian Institute of Housing and Welfare (2018)³²³

Due to increasing house and rental prices and a lack of affordable housing options, there are limited pathways for people to transition from social housing into the private market. As private market prices have risen, the gap between it and subsidised social housing has increased.

The prioritisation of social housing towards higher needs tenants also makes it less likely that social housing tenants will be able to transition through to the private market. Most social housing tenants rely on some form of government subsidy, such as Commonwealth Rent Assistance, to be able to pay their rent. A high percentage of social housing tenants also report living with disability and a

significant percentage are aged over 55, which means that many social housing tenants may be unable to work.

Disincentives to seeking paid employment, such as social housing rents increasing as earning increases, also act as barriers. The proportion of social housing tenants exiting to other housing types has been relatively stable between 2012 and 2017. In 2012, 6.6% of households in public housing exited (move successfully into the affordable or private market), compared to 6.9% in 2017.³²⁴

Of those who are able to transition out of social housing, there are limited opportunities or incentives to do so. Limited investment in delivering affordable rental housing and high demand in the lower end of the private rental market means that there is often nowhere for social housing tenants to transition to, even in the event that their earning capacity improves. Affordable rental housing can play an important role by providing a stepping stone in the transition between social housing and the private market for households that would otherwise find themselves in housing stress in the private market. Without a well-functioning affordable rental housing sector, these families and individuals may slip even further down the housing continuum into social housing or severe rentals stress and homelessness.

The affordable rental housing sector is smaller (per capita) in Australia than other jurisdictions such as England and the Netherlands.³²⁵ Nationally consistent data indicating the commitment to and delivery of affordable rental housing does not exist. However, it is expected that between 2015 and 2020, affordable rental dwellings will make up around 3% of total new dwellings delivered across Australia (around 32,000 dwellings).³²⁶ This falls short of expected demand for this housing type. It is estimated that around 12% (or 23,000) of the 1.7 million newly forming households are likely to face housing stress in the private market.³²⁷

Not only is delivering new affordable rental supply a challenge, but protecting existing supply into the future will be difficult as dwellings delivered under the National Rental Assistance Scheme (established in 2009 and discontinued in 2016) required them to be provided at affordable rental prices for a minimum of 10 years. This means the 37,142 planned dwellings will be eligible to transition to private market rates between 2019 and around 2026, resulting in a loss of affordable rental supply over this period.³²⁸

'Build to rent' models can provide more rental supply and stability

An emerging model for rental housing supply, which has proved successful in the United States and more recently in the United Kingdom is institutional rental investment or 'build to rent'.

This approach involves the construction of purpose-designed apartment blocks, held in single ownership for long-term renting. In the United Kingdom, mainstream market 'build to rent' development began in 2012 and has delivered over 140,000 units over that period and has built longer term stability, increased supply and greater choice for renters.³²⁹

In Australia, the build to rent model has delivered specific purpose rental supply, such as student accommodation, 'new generation' boarding houses, and affordable rental homes developed by CHPs. However, the development industry is beginning to invest in mainstream build to rent, which is seen as an emerging asset class. Australia's current tax settings, designed for a 'build to sell' model, have been identified as the major barrier to the delivery of a large-scale mainstream build to rent sector in Australia.³³⁰

123. Challenge

There are limited pathways for people to move through the housing continuum, particularly from social housing into the private market. Without adequate affordable housing options for people on different income levels, people may remain in social housing for longer, occupying homes that could be provided to people in greater need.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:





Our social housing system is under pressure

The social housing system in Australia is under significant pressure. Nationally, the social housing system suffers from a lack of funding, an ageing housing stock with high maintenance needs, increased demand due to housing affordability issues, insufficient funding to increase the supply of dwellings in the system, and tenants with increasingly diverse needs.

Social housing made up 4.2% of the dwelling stock in Australia in 2016, down from 5.1% in 2001.³³¹ While the number of new social housing dwellings has increased 5.4% over the past decade,³³² the number of social housing dwellings has not kept pace with the growth in Australian households, relative to other housing types.

In 2016–17, there were 396,100 households living in social housing across Australia with an additional 189,400 households on the waiting list.³³³ Due to high demand and a lack of dwellings, social housing allocation is prioritised according to highest and greatest needs. This prioritisation of social housing results in an increasingly vulnerable tenant cohort with a high number of tenants with complex health issues, elderly tenants and tenants living with disability. According to the Australian Institute of Health and Welfare, approximately 39% of social housing households report having a tenant experiencing disability, while approximately 53% of social housing tenants are over 55.³³⁴

The prioritisation of social housing for highest needs individuals has changed the demographics of tenants. In public housing, the number of single person households has risen from being statistically indistinguishable in 1970,³³⁵ to making up 55% of households in 2016-17.³³⁶ Over the same period, ‘couples with children’, has fallen from making up 70% of public housing households in 1970,³³⁷ to just 3% in 2016-17.³³⁸

This shift means that the configuration of Australia’s social housing stock is no longer aligned to demand. In 2017, the majority of the existing social housing stock in Australia consisted of dwellings with two or more bedrooms and 37% of public housing dwellings had three bedrooms.³³⁹ The misalignment of stock to demand means that 54% of public housing dwellings were tenanted with empty rooms in 2011.³⁴⁰

Ageing stock coupled with poor maintenance means social housing is struggling to meet the needs of its tenants

Compounding the pressures of a shortfall in the number and type of public housing dwellings are a deteriorating asset base and maintenance challenges. Public housing estates built in the post-war era are now entering their sixth or seventh decade, meaning that dwellings increasingly require substantial maintenance and upgrades. Commonly this means utility infrastructure and heating and cooling systems require upgrading or replacing, while building materials are weathered and aged. Ageing public housing assets and a rising maintenance backlog will be an ongoing challenge for governments and provides poor outcomes for tenants. In 2012 the New South Wales Government estimated the state’s public housing maintenance backlog at \$300 million.³⁴¹ The Victorian Auditor General found that the state’s public housing maintenance backlog increased from \$22 million in 2013 to \$227.5 million in 2016, in part due to postponed renewal programs.³⁴²

Funding for social housing maintenance is generally derived from tenants rents, which do not rise at the same rates as private sector rents, largely due to the safety net role of social housing and a limited increase in the amount of welfare support provided to low-income households for housing expenses. In New South Wales, social housing rents only cover 42% of the yearly cost of managing and maintaining the stock of public housing.³⁴³ In addition, public funding of public housing has been declining in New South Wales. While this issue has led to stock transfer initiatives there is still a question mark over how to address the large gap in funding.

The community also recognises that social housing is not meeting community expectations and is difficult to access. Infrastructure Australia research found one in four Australians believe that the quality of social housing is worse than five years ago, with a similar proportion also believing that the quality is likely to get worse over the next five years. The ability to access social housing was identified as difficult by 29% of people.³⁴⁴



124. Challenge

Australia's social housing stock is not meeting current or projected tenant needs in terms of dwelling sizes and configurations, accessibility and supporting services. Without action, reduced access to adequate and high-quality housing can create adverse impacts on other aspects of peoples' lives, including their health, employment opportunities, educational attainment and broader wellbeing and life satisfaction.

When this will impact:



Where this will impact:



125. Challenge

Australia's social housing asset base is deteriorating and there is an increasing maintenance task, affecting the quality of dwellings. Failure to properly maintain dwellings can exacerbate maintenance costs and create negative health and well-being impacts for tenants.

When this will impact:



Where this will impact:



Overcrowding is leading to poor outcomes for Aboriginal and Torres Strait Islander peoples in remote areas

Housing is at the centre of addressing Aboriginal and Torres Strait Islander inclusion and disadvantage across Australia. Aboriginal and Torres Strait Islander peoples today face systemic barriers to accessing stable, affordable housing that is suitable to their needs. These housing challenges are often distinct to those facing other Australians, such as overrepresentation in Australia's homeless population, the need for culturally appropriate housing, overcrowding of housing and the proportion of Aboriginal and Torres Strait Islander peoples living in remote or very remote areas, where it is difficult and expensive to deliver new housing supply.

Access to stable and adequate housing for Aboriginal and Torres Strait Islander populations forms a key part of the Australian Government's *Closing the Gap* strategy to reduce significant inequalities experienced by Aboriginal and Torres Strait Islander peoples. The 2019 *Closing the Gap* Report confirms that Aboriginal and Torres Strait Islander peoples continue to experience poorer housing outcomes than other Australians and that inadequate housing has serious negative implications for health, education and employment.³⁴⁵

Inadequate housing can lead to poor physical and mental health for communities. Overcrowding and insufficient access to functional hygiene facilities in remote Aboriginal and Torres Strait Islander housing can result in high rates of infectious diseases, and has been linked to the spread of common illnesses such as influenza. Overcrowding can also exacerbate domestic and family violence, which often takes place in a context of poor housing conditions, overcrowded dwellings and insufficient supply of housing including crisis accommodation for victims of violence or abuse.³⁴⁶ Inadequate housing can also negatively impact the educational outcomes of Aboriginal and Torres Strait Islander young people, due to a lack of housing stability and insufficient space to study or sleep.

The 2019 *Infrastructure Priority List* estimates that the combined economic and social cost of overcrowding for remote Aboriginal and Torres Strait Islander populations is expected to exceed \$100 million per annum over the next 15 years based on existing overcrowding rates.³⁴⁷ However, after accounting for population growth, an additional 5,500 homes are still expected to be required by 2028 to reduce levels of overcrowding in remote areas.³⁴⁸ Half of the additional need is in the Northern Territory alone, a jurisdiction with the lowest capacity to meet this pressure because of its limited revenue raising capabilities and high proportion of the population receiving government support.

National Partnership Agreement for Remote Indigenous Housing

A National Partnership Agreement (NPA) for Remote Indigenous Housing led to a significant reduction in overcrowded households in remote and very remote areas between 2008 and 2018. A review of the NPA and the *Remote Housing Strategy 2008-2018* noted that the Strategy will have delivered over 11,500 more liveable homes in remote Australia (around 4,000 new houses and 7,500 refurbishments) by 2018.³⁴⁹ This contributed to rates of overcrowding falling from 52.1% in 2008 to 41.3% in 2014-15.

In 2014-15, 21% of Aboriginal and Torres Strait Islander people across Australia were assessed as living in overcrowded conditions, of which 41% were in remote areas.³⁵⁰ Of these, 54% live in the Northern Territory, around 20% in each of Queensland and Western Australia, 5% in remote South Australia and 2% in remote New South Wales. The percentage living in overcrowded areas is forecast to fall further to 37.4% by 2018. However, funding under the strategy concluded in 2018 and it has been replaced with state and territory short-term funding schemes.³⁵¹

Challenges for housing in remote Western Australia

Remote communities in Western Australia are challenged by overcrowding, deteriorating housing conditions and complex system of municipal service delivery.

About 12,000 Aboriginal people live in remote communities in Western Australia. Aboriginal communities across the state are diverse, ranging from large settlements with significant infrastructure and populations' equivalent to small towns, to family groups who seasonally visit sites which have little to no infrastructure.

The population of remote Western Australian communities is projected to rise. Overcrowding remains a significant issue and will worsen without ongoing investment. Any increase in housing provision requires a corresponding investment in the capacity and quality of essential and municipal services and other infrastructure.

Poor health outcomes associated with overcrowding and poor quality housing include increased risk of transferring infectious diseases, higher recurrence/exacerbation of chronic infections and increased risk of injury. Overcrowding and poor housing quality can also negatively impact employment outcomes and make it difficult for children to study at home, leading to

increased stress which adversely impacts upon school performance. Furthermore, increased pressure in homes means that tension and violence can be exacerbated. Anticipated population growth will place pressure on the ability for the State to handle the consequential increased demand for Government Regional Housing (extra need for more teachers, police and child protection workers) and the capacity of power, water and waste water to handle additional demand.

The previous National Partnership on Remote Housing resulted in 846 new builds and 1,705 refurbishments in Western Australia. Approximately 41% of all employees under the capital works program were Aboriginal. Funding for cyclic maintenance and asset management is essential to prevent the deterioration of houses built under the previous partnership and protect local employment opportunities.

The State Government's Essential and Municipal Services Program is aimed at improving the standards of infrastructure in remote communities in Western Australia, with a focus on delivering critical upgrades to water, wastewater and municipal infrastructure and establishing appropriate municipal services delivery arrangements.³⁵²



126. Challenge

Remote Aboriginal and Torres Strait Islander housing is not meeting the needs of communities, due to overcrowding and poor quality dwellings. Inadequate housing exacerbates the health, education and well-being outcomes of Aboriginal and Torres Strait Islander peoples, which are already below those of other Australians.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



There is a growing role for the community housing sector

Pressure on the social housing system in Australia means that governments around the country are increasingly relying on not for profit CHPs to deliver housing and services to people in need. CHPs already play a significant role in providing social and affordable homes around the country, and their involvement is increasing.

Over the last decade there has been a very slight overall increase in the number of social housing dwellings in real terms.³⁵³ According to the Productivity Commission, between 2005–06 and 2015–16 the number of public housing dwellings decreased by 21,300 dwellings overall.³⁵⁴ Over the same period, mainstream community housing increased from 32,300 dwellings to 80,200 dwellings.³⁵⁵

The strong growth in the mainstream community housing sector is the result of the Australian, state and territory governments actively seeking to build the CHP sector, through the transfer of title or (more commonly) management of social housing dwellings to CHPs. Housing Ministers from all jurisdictions committed to a community housing growth target, under which up to 35% of social housing would be owned and/or managed by CHPs by 2014.³⁵⁶ There has also been a recent focus by governments to enable CHPs to borrow at lower interest rates (through mechanisms such as the National Housing Finance and Investment Corporation) in order to facilitate the growth of the sector.

Government transfers of public housing dwellings to CHPs reduces the costs of delivering social housing for state governments, because CHPs are able to access Commonwealth Rent Assistance and take advantage of favourable tax settings which helps to plug the gap between market and below market housing.

In a context of limited funding for new capital programs in social housing, governments are relying on the non-government CHP sector to take on a more significant role. Many of the innovative models for delivering social housing currently underway (such as Communities Plus and the Social and Affordable Housing Fund in New South Wales, management transfer programs in Victoria and New South Wales, and the Victorian Social Housing Growth Fund) rely on the increased participation of CHPs and the growth of the sector. It is important to note that while CHPs have a critical role to play within Australia's social housing system, without additional government support (through policy, financial means and land use planning regulation), the sector as a whole will not be able to grow at the scale required to meet demand.

127. Opportunity

The community housing sector is growing, supporting governments to deliver high-quality services to social and affordable housing tenants. Leveraging further growth in the sector can increase innovation in social and affordable housing delivery and management, and improve the quality of housing services for tenants.

When this will impact:

0-5

5-10

10-15

15+

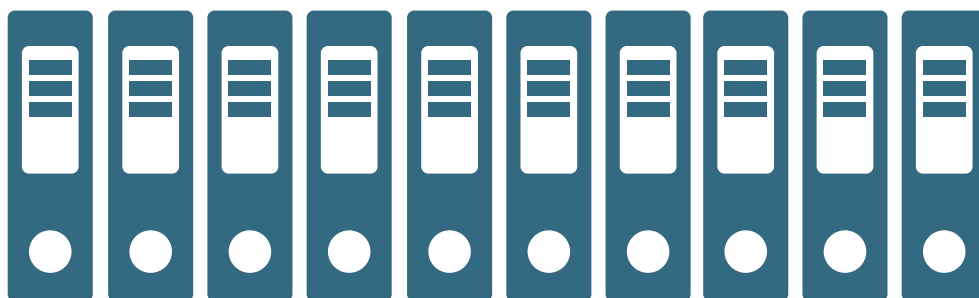
Where this will impact:



Performance of justice and emergency services infrastructure

Quality

There is a
National backlog
of around
383,870 cases
in criminal and
civil courts³⁵⁷



Access

Female prison population in
Australia has increased
10% annually,
from 2008 to 2018³⁵⁸

Cost

\$7,300

is the average cost of bringing a case in
the Administrative Appeal Tribunal³⁵⁹



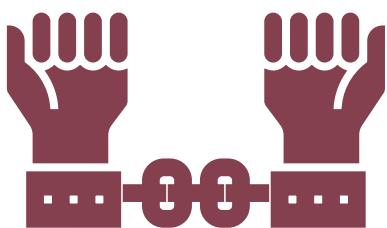
Emergency service response times

Access

can be **4 times longer** for regional and remote areas than in urban areas³⁶⁰



Cost



\$144,480

was the average cost per prisoner in 2014³⁶¹

Quality

61%

thought ambulance arrival time was 'quicker than
they thought it would be'³⁶²



Scale of justice and emergency services infrastructure

Asset

Nearly one third of NSW fire stations are **heritage listed** ³⁶³



Customer

There are

40,000
prisoners across Australia ³⁶⁴

Industry

Prisons are accommodating **15% more inmates** than their designed capacity ³⁶⁵



Industry

1/2 of prisoners

return to correctional services within 2 years ³⁶⁶



Customer



3.7m
incidents reported to ambulance service organisations in 2017–18 ³⁶⁷

Industry

State and territory emergency services:



20,297
paid staff



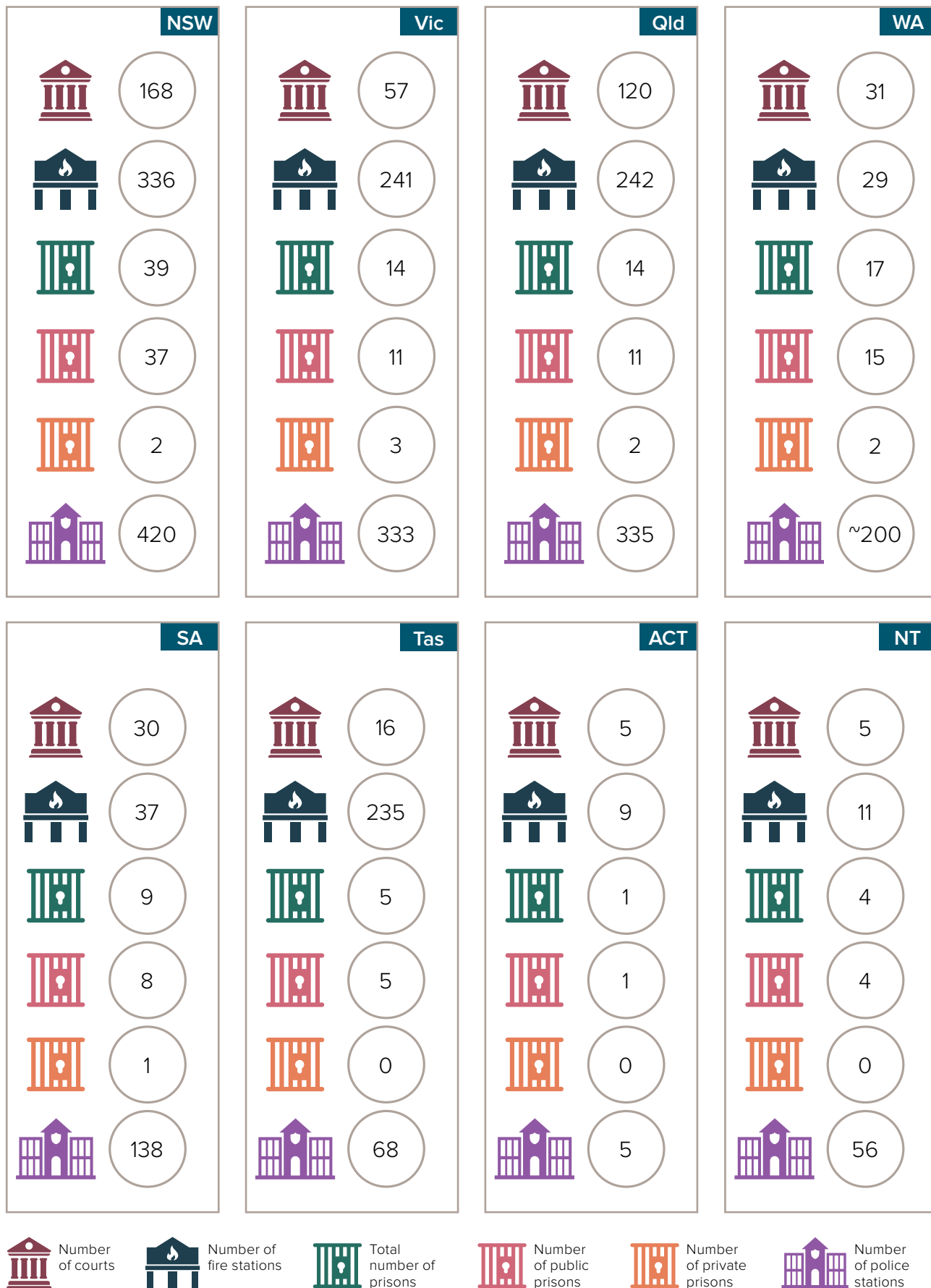
212,293
volunteers ³⁶⁸

Customer



emergency incidents
per hour
in 2017-18 ³⁶⁹

Scale – by state and territory



Notes: Number of fire stations reflect only the number of career fire stations where this figure is distinctly reported.

Source: Based on EY analysis for Infrastructure Australia and supplementary engagement with relevant jurisdictions.

6.7 Justice and emergency services

Sector overview

Justice and emergency services infrastructure comprises the buildings and facilities which protect and support the safety of our communities. Together these services uphold civil rights, prevent and respond to crime, resolve disputes, respond to emergencies and natural disasters, and often engage with the most vulnerable Australians. It includes:

- **Justice infrastructure:** police stations, local, district, supreme and federal courts, adult and juvenile correctional facilities, and forensic health facilities.
- **Emergency services infrastructure:** fire and ambulance stations, and other state and local emergency response facilities, such as state emergency services.

This Audit focuses on all types of justice and emergency services infrastructure. Other health services infrastructure, such as hospitals and emergency departments, are considered in Section 6.2.

At a glance

Justice and emergency services are in flux as the nature and rate of crimes, emergency events and community health change. Much of our justice infrastructure is not located where it is needed, and much of it is ageing and not fit-for-purpose.

This section discusses the complexity and interdependency of justice and emergency infrastructure. There is a lack of coordination across and between governments, but digital solutions are helping to improve services.

The nature of justice and emergency services is changing

Justice and emergency services infrastructure is often directed to our nation's most vulnerable citizens, and when it is delivered effectively, it plays a necessary role in maintaining our liveability and safety of communities. However, ideally, people would not use justice and emergency services infrastructure.

While the need for these services will continue, and demand will rise with population growth, the incidents and behaviours this infrastructure responds to are also evolving, and infrastructure needs to adapt. Although rates of crime are declining nationally, the complexity of offences and sentencing is increasing, resulting in court backlogs and pressure on remand infrastructure.³⁷⁰ Changes to crime policy also impact the level of demand for justice infrastructure. Globalisation has increased the prevalence of crimes such as terrorism, and technology advances have resulted in new types of crime, such as cybercrime. These novel and multi-faceted offences require suitable system and infrastructure responses. The complexity of these cases add to the nationwide court case backlog and increasing remand population.

Adding to the complexity of the changing nature of crime, Australian prisons are among the most expensive in the world to build, operate and maintain,

costing governments on average \$144,480 per prisoner annually, behind Sweden, Norway, the Netherlands and Luxembourg.³⁷¹ Australia also spends significantly on police services, with just over 65% of total justice spending allocated to police, and just over 25% allocated to corrective services.³⁷²

Advances in data analysis and technology, and health care and education services mean that we have a better understanding of factors (such as poverty and disadvantage, mental health, trauma and abuse), which contribute to a person requiring correctional intervention. This information and awareness have changed the delivery of justice services from punitive-based approaches to a focus on restorative or rehabilitative justice. This requires changes to existing justice infrastructure and a changed approach to the planning and design of new infrastructure.

The nature of emergencies is also changing. The impacts of climate change are being felt in Australia via an increase in the occurrence and intensity of natural disasters and extreme weather events, putting strains on current services and supporting infrastructure.³⁷³ Our population is also ageing, which places greater demands on ambulance services and requires additional infrastructure and re-orientation of the systematic approach.

The location of justice infrastructure assets and demand are misaligned

Justice services occupy a large amount of land nationally, but the majority of this land is unevenly distributed in relation to population density and poorly located in proximity to other services.

Networks of police stations, courts and correctional facilities were initially established to serve historical settlement patterns and expectations of service. While demographic changes (such as population growth and urbanisation) can affect patterns of demand for justice infrastructure, changes in policy (such as stances on particular crimes, or bail arrangements) can have real and significant impacts on demand on these facilities. Re-offending also places additional pressure on corrective infrastructure. In Australia, over half of the prisoners released in 2015-16 had returned to corrective services (either prison or community corrections) within two years.³⁷⁴

Australia has more than 40,000 people in incarceration nationally.³⁷⁵ This has grown by 39% in the last 10 years and is more than double the OECD average.³⁷⁶ This growth has resulted in much of our corrective services infrastructure currently operating at or beyond capacity, as Figure 13 shows.³⁷⁷ Nationally in 2017-18, correctional facility utilisation was at 115.6% of design capacity across the country.³⁷⁸

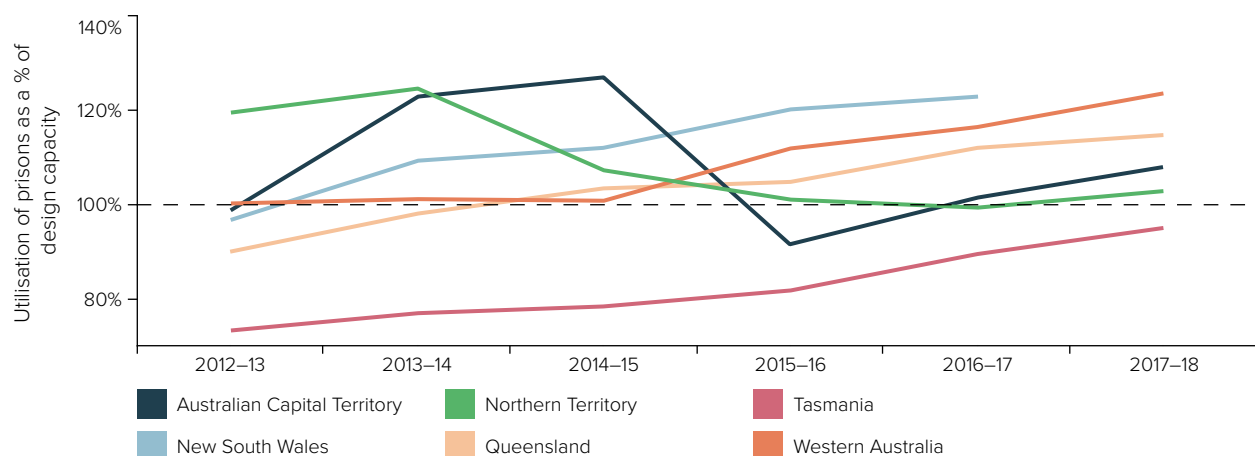
Due to population growth around our fast-growing cities, correctional facilities located in and around these cities are generally operating at or over

capacity. At the same time, many regional courts are underutilised, most likely due to their location and relative population sizes. For example, while some courts in New South Wales experience case backlogs, 50% of courts hear matters less than five days a month.³⁷⁹ While these trends are evident, detailed data showing the distribution of court and corrective asset utilisation by urban and regional areas is not publicly available.

This misalignment between justice infrastructure assets and demand has contributed to overcrowding in prisons and juvenile facilities, reducing the quality of our correctional services infrastructure. For example, overcrowding may inhibit adequate surveillance, or reduce the number of beds, both of which can lead to health and safety issues for inmates and staff.³⁸⁰ The rate of prisoner-to-prisoner assaults and prisoner-to-staff assault has increased between 2012 and 2017,³⁸¹ particularly in over utilised facilities, which is likely to be linked to the short term measures used in corrective facilities to manage capacity constraints.

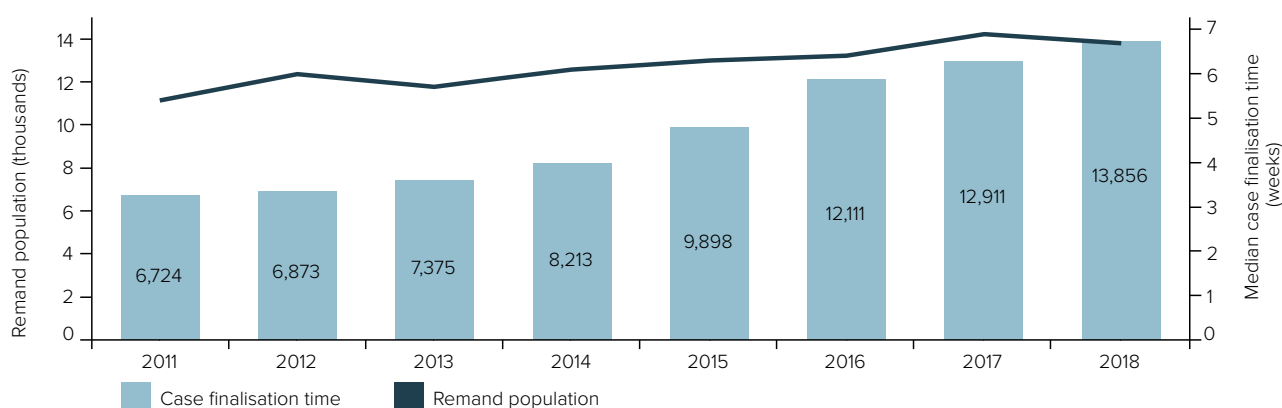
Increased overcrowding in prisons is in part due to an increase in the remand population (Figure 14). Remand prisoners (those who have been detained and are awaiting sentencing in court) represented 32% of the prison population nationally in 2018, and are increasing as the backlog in criminal courts worsens.³⁸² In 2017-18, the average time required to finalise a case was 17.3 weeks, but the median time was much lower at 6.7 weeks.³⁸³ This means that most cases are finalised quickly, but there are some cases that take much longer, with 6% of cases in 2017-18 taking over one year to be finalised.³⁸⁴

Figure 13: Most of Australia's prisons are operating at or above their design capacity



Note: Percentages represent the annual daily average prisoner population divided by the number of beds. Victorian and South Australian figures are not reported.

Source: Productivity Commission (2019)³⁸⁵

Figure 14: Australia's remand population and median case finalisation times are increasing

Source: Australian Bureau of Statistics (2018, 2019)³⁸⁶

This backlog has significant impacts on the broader justice system and supporting infrastructure, especially in fast-growing cities. In the case of remand prisoners, delayed cases and hearings require the individuals to be held for a longer period of time in adequate facilities and with supervising staff, in addition to transport to and from hearings while they are in remand. This requires a suitable infrastructure response. However, it has been difficult to provide the necessary infrastructure to accommodate the average annual growth rate of just under 12% in remand populations across Australia between 2010 and 2018.³⁸⁷

In Victoria and New South Wales, remand populations have recently increased substantially as a result of policy changes to bail and sentencing legislation implemented in January 2015, in response to major public safety incidents, such as the Lindt café siege in Sydney and the Bourke Street mall attack in Melbourne.

Ageing justice infrastructure is not fit-for-purpose for changing user needs

Justice services infrastructure has one of the largest heritage asset bases in government. This infrastructure is often difficult to adapt to modern operations and has experienced insufficient investment for functional upgrades to keep pace with advances in technology. The heritage status and extent of work required to maintain most heritage assets make upgrades and adaptations increasingly

complex, as noted in the *Court Services Victoria Strategic Asset Plan 2016-2031*.³⁸⁸ At the same time, the profile of users within the justice system is also changing. These infrastructure limitations impact on the service quality for people using police stations, courts and correctional facilities. Currently, more Australians feel service quality for justice infrastructure has become worse rather than better, when compared to five years ago.³⁸⁹

Across Australia, the profile of justice services users has changed. The proportion of women, Aboriginal and Torres Strait Islander people, and young people moving through the justice system, is increasing. At the same time, the average age of users is increasing, and users are more likely to be people with disability or experiencing mental health issues.³⁹⁰ Our courts are also experiencing an increasing number of terror-related, multi-accused and domestic violence cases being lodged and heard.³⁹¹

Ageing heritage buildings and facilities are often not fit-for-purpose for these users, and it can be a challenge to retrofit ageing buildings with disabled access or additional space for specific uses.³⁹² For example, most courts do not provide appropriate segregation facilities to separate domestic violence victims from the alleged defendants, due to a lack of available space. This will become an increasing challenge if the number of domestic violence cases continues to increase in the majority of states and territories.³⁹³

128. Challenge

The location of justice infrastructure assets is misaligned with demand, due to population growth and urbanisation. If left unaddressed, this will result in reduced quality of, and reduced accessibility to our justice services, particularly correctional services.

When this will impact:



Where this will impact:



People with disability, particularly cognitive or psychosocial impairments, account for almost 50% of Australians entering prison, again resulting in strain on justice infrastructure's ability to provide access to health services.³⁹⁴ This reinforces the role justice and emergency services play in supporting more vulnerable citizens, and highlights the importance of facilities being accessible and fit-for-purpose in supporting these users. In response to this issue, some jurisdictions have delivered policies and facilities to specifically treat and support inmates with disability, including Western Australia,³⁹⁵ and New South Wales.³⁹⁶ For example, the Bennett Brook Disability Justice Centre in Western Australia is the state's first to provide residential services for people accused but not convicted of a crime and who are unfit to plead guilty because of disability.³⁹⁷

There remains a disproportionate representation of Aboriginal and Torres Strait Islander peoples in correctional facilities across the country.³⁹⁸ While there are very few justice facilities on country across Australia, Victoria and New South Wales have introduced Koori Courts to support a more accessible and culturally relevant court system for Aboriginal and Torres Strait Islander communities.³⁹⁹ In the Northern Territory, bus services are provided to the Territory's two prison facilities to enable friends and family to more easily visit inmates.

The number of female inmates has been growing. Over the past 5 years the number of females in custody increased by 38%, intensifying pressure on existing female corrections facilities.⁴⁰⁰ Women have specific needs when being held in correctional facilities that have been mandated in the United Nations Rules for the Treatment of Women Prisoners and Non-custodial Measures for Women Offenders (the Bangkok Rules).⁴⁰¹ These requirements include being held in correctional facilities close to their home and the provision of gender-specific health care in supporting facilities. As a result, an increasing female inmate population has required a suitable

infrastructure response. This has been achieved by upgrading existing assets such as the recent expansion of the Adelaide Women's Prison in South Australia,⁴⁰² or via delivery of new, purpose-built facilities for female inmates such as Dillwynia Correctional Centre in New South Wales.⁴⁰³

The Australian prison population is also ageing. The proportion of prisoners over the age of 50 rose from around 10% to 14% of the total prison population over the last three years alone.⁴⁰⁴ This is due to an ageing population and changes in prosecution and sentencing laws including mandatory minimum sentencing and reduced options for early release.⁴⁰⁵ Existing facilities were not designed to cater for an older population. This reduces the quality of services for this growing cohort, while older Australians are currently 20% more likely to view access to justice services as difficult.⁴⁰⁶ Prison environments and regimes can exacerbate health issues for older inmates and increase their vulnerability to victimisation.⁴⁰⁷ Accommodating older inmates can also cost up to three times as much as younger inmates.⁴⁰⁸ This directly impacts infrastructure planning. For example, increasing requirements for physical and mental health care, and changes to physical facilities (such as ramps or handrails).⁴⁰⁹

Although the prison population is ageing on a national scale, the Northern Territory's justice infrastructure serviced the highest per capita youth population in 2016-17, with 746 youth prisoners aged from 10 to 17 years. While increasing numbers of youth are entering the justice system in other jurisdictions, the Northern Territory has the highest rate in the country.⁴¹⁰ This has put pressure on the Territory's existing infrastructure and service level standards.⁴¹¹ In this instance, existing corrective services assets are often not fit-for-purpose to deliver appropriate therapeutic (personal development, skill building, counselling)⁴¹² and rehabilitative methods required for younger prisoners.

Youth detention in the Northern Territory

Following the recent Royal Commission into the Detention and Protection of Children in the Northern Territory, the Territory has changed its approach to youth detention and is considering the appropriate infrastructure response.

The Royal Commission found that the 'conditions under which children and young people were detained fell far short of acceptable standards under international instruments and Australian guidelines. Severe, prison-like and unhygienic conditions, and inadequate security due to poor infrastructure, caused children and young people to suffer punishment'.

In summary, the infrastructure and services provided in the facilities did not support the delivery of services in a therapeutic, non-punitive, non-adversarial, trauma-informed and culturally competent way.⁴¹³



129. Challenge

Ageing justice infrastructure assets are not fit-for-purpose for changing user demographics and needs. Without changes to the design of justice infrastructure and services provided to adapt to changing types of users and needs, diverse users will experience increasingly poor quality services.

When this will impact:

0-5

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Where this will impact:



Emergencies are changing in nature and infrastructure is not keeping pace

Emergencies are changing in nature, scale and frequency across Australia. The incidence of residential fires have decreased by 20% across the country over the past 10 years, likely due to improved design and building material safety.⁴¹⁴ At the same time, the impacts of climate change are being felt by emergency services infrastructure as bushfire seasons increase in length and intensity, and are occurring in places they never have before. More high-intensity tropical cyclones are hitting our northern coastlines, creating destruction and at times flooding impacts for communities. Other changes are also occurring – the number of people over the age of 80, who disproportionately require ambulance services, is increasing, and the threat of terrorism is rising, particularly in our fast-growing cities.

Despite these changes, emergency services must continue to reach people where they need help. This means fire and ambulance stations must be located where services can rapidly and easily access a large range of places, and must have space for the equipment and personnel required to respond to these changing types of emergencies. However,

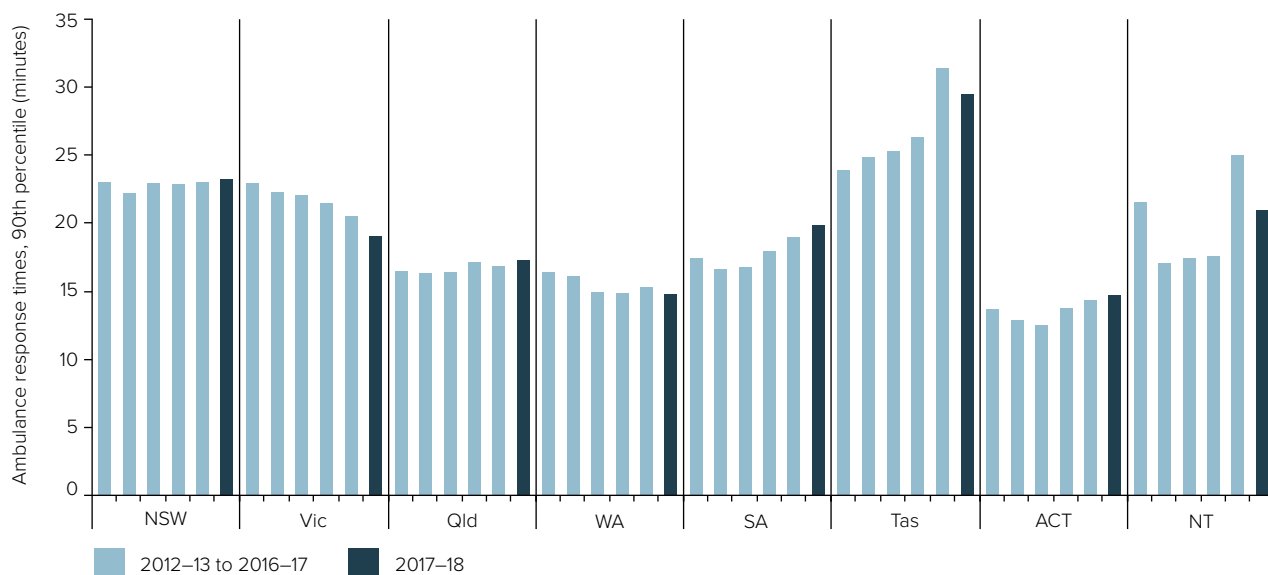
emergency services assets remain relatively static, often bound to historical service models that rely on inflexible, permanent and often ageing infrastructure. In New South Wales, one quarter of all fire stations are heritage listed with some unable to fit modern vehicles on the premises.⁴¹⁵ This impacts the quality and accessibility of our emergency services infrastructure. For law enforcement, increasingly sophisticated security and surveillance technology is improving the ability to monitor safety and prevent crime from happening or obtain evidence when it does. However, this technology is owned and operated in a fragmented way, across both governments and the private sector, limiting the capacity for law enforcement to use these tools in an integrated way.

Accessibility to emergency services is typically measured by response times. As Figure 15 shows, while response times are comparable across all jurisdictions, they have risen across Australia (with the exception of Victoria and Western Australia) since 2013. However, improved response times were recorded in 2018, in particular for Tasmania and the Northern Territory where times are longer than for other states.

Access to emergency services is low in rural communities and remote areas, due in part to the vast distances and low population densities of these areas. Response times for structural fires vary significantly between major cities and remote and very remote areas, with an average difference of 29 minutes in South Australia, and 19 minutes in Western Australia.⁴¹⁶

For example, the Northern Territory relies on a network of fire stations to service the vast majority of communities that are largely rural and remote, and have small populations. Although a fire station network runs down the spine of the Territory, there are some communities that rely solely on fire emergency services by air. For example, while it has a volunteer emergency services unit, Numbulwar is over 10 hours' drive from Mataranka and Katherine, so would not be effectively supported by key territory services during emergencies.⁴¹⁷

Figure 15: Ambulance response times have risen in many jurisdictions over the past 5 years



Source: Productivity Commission (2018, 2019)⁴¹⁸

130. Challenge

Our emergency services infrastructure is not adapting to changes in the nature and rate of emergencies. Without action, emergency services infrastructure which is not fit-for-purpose for the changing nature of emergencies will reduce access to life-saving services, particularly in rural communities and remote areas.

When this will impact:



Where this will impact:



Coordination between justice and emergency services and other sectors is a challenge

Justice and emergency services are highly interdependent and demand is sensitive to changes in policy and law. For example, a recent review in New South Wales found that for every 4,300 incidents recorded by police, around 1,200 criminal lodgements result in the court proceedings, almost 800 court finalisations are processed, and the prison population increases by over 350 people.⁴¹⁹ Demand for justice services can also be impacted by government decisions across other portfolios such as education, health and housing, requiring collaboration across portfolios to address cross-sectoral issues. For example, the efficiency of ambulance services relies on the efficiency of health service, specifically emergency departments.

The close relationship between justice and emergency services is evident in all states and territories. However, governance structures, specifically in New South Wales and Queensland where justice and emergency services agencies operate independently, can make it challenging to effectively coordinate infrastructure planning, funding and service delivery. Due to this lack of integration and coordination, investment in justice and emergency services has been more

reactive than proactive. Reactionary decisions and operations result in inefficient use of funds and missed opportunities to improve service quality and accessibility.

The changing nature of crime is requiring greater collaboration between jurisdictions. Crime is becoming increasingly placeless. Supported by technology, online crimes transcend state borders, and perpetrators and victims can be in different states or even countries. The increasing prevalence of this type of crime is demanding a coordinated response from justice and emergency services nationwide, including with the Australian Federal Police and Australian Government's Department of Home Affairs.

Coordination across portfolios within states and territories is also increasing. For example, 'problem solving' courts, such as Australian drug courts, help users address their underlying illicit drug problem within the criminal justice system.⁴²⁰ These courts are a successful example of collaboration between justice and health portfolios in managing cases, and have delivered reduced rates of recidivism, thereby reducing future demand on justice infrastructure. Co-locating justice infrastructure with emergency service infrastructure is also enabling more efficient emergency management and service delivery through shared resources.⁴²¹

Ravenhall Correctional Centre

Forensicare operates the largest prison-based forensic mental health service in Australia from Ravenhall Correctional Centre (Ravenhall) in Victoria. Victorian prisons have been over-burdened by shouldering demand for other social services, particularly mental health. Further, these facilities are not appropriately equipped to manage these types of user needs.

The co-location of Forensicare Mental Health Service at Ravenhall provides 75 forensic mental health beds and a large outpatients program, relieving overburdened prisons of the demand for these complex services.⁴²²

131. Opportunity

There is a high level of interdependence between justice and emergency services, and with other sectors, such as health. The changing nature of crime and emergency events provides opportunities to improve coordination across sectors to deliver more holistic, and higher-quality services, and improve accessibility through approaches such as jointly-managed facilities and programs.

When this will impact:

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Where this will impact:



Digital technology and operational changes are helping to reduce demand on physical justice assets

Capital investment in justice infrastructure will continue to be needed to meet increasing demand on currently over-utilised assets. However, rather than building new infrastructure, policy solutions are increasingly being considered as a cost effective way for governments to reduce demand and potentially deliver higher quality services, particularly using new technology and making changes to operations. While many of the ‘non-build’ approaches delivered by government harness new technologies and digitalisation, non-digital approaches, such as alternative dispute resolution, have also proven effective in some jurisdictions, for example in Victoria.

In the civil justice system, Australians are embracing technology like never before and increasingly expecting high-quality digital services.⁴²³ Uptake in online court lodgements and registration of online births deaths and marriages has been significant, reducing pressure on physical assets.

In the criminal justice system, technology is reducing reliance on physical infrastructure, improving security

and streamlining information access. Mobile devices can help reduce the need for police officers to return to police stations, while audio visual links in prisons and courts are reducing the need to transport inmates to appear in court and online filing is improving information integrity and accessibility.

The OECD has found that justice systems devoting a larger share of their budget to information technology achieve shorter average trial lengths, as well as higher productivity from judges.⁴²⁴ There are international examples of the ability for technology to support reductions in inmate population numbers.

For emergency services, digital communication networks are enabling early warning services for major disasters or events. Technology has also helped to improve the mobilisation and coordination of emergency services, particularly volunteers, and enabled centralised management of emergency response. New South Wales is in the process of delivering the Critical Communications Enhancement Program, which aims to consolidate a large number of radio networks owned and operated by various agencies to facilitate more streamlined communications and coordinated responses between emergency services agencies.⁴²⁵

New Zealand’s prison population crisis

New Zealand’s prison population dropped by 7% in six months during 2018. The New Zealand Government had announced earlier in the year that it would build a new 600 bed facility at Waikeri, and there were consistent reports of over-crowded prisons and high risk accommodation responses.

Ahead of longer-term changes to legislation, the Government acted in the short term to seek out inefficiencies and attempted to eliminate them. These initiatives included utilising electronic monitoring and additional assistance in completing bail applications properly. These simple reforms have been successful in reducing New Zealand’s prison population from overcapacity.⁴²⁶



The Maranguka Justice Reinvestment Project, Bourke NSW

New approaches to justice, including preventive models, have proven successful in reducing the demand on justice infrastructure and services, and improving community wellbeing more broadly.

The town of Bourke in north west New South Wales is the site of the first major pilot project in Australia for an Aboriginal-led, place-based 'justice reinvestment model' which redirected funding from crisis response, adult prison and youth detention towards preventive, diversionary and community development initiatives.

The estimated changes in Bourke attributed to the project between 2016 and 2017 alone include:

- A 23% reduction in the number of violent incidents reported to police
- A 31% increase in the retention rate for year 12 students
- A 42% reduction in the number of days spent in custody for adults
- An 83% increase in the number of drivers' licences obtained through the Birrang Learner Driver Program.⁴²⁷

132. Opportunity

Digital technology and operational changes are providing 'non-build' ways to improve justice infrastructure efficiency and service quality. Harnessing these advancements can reduce demand on existing physical infrastructure and improve the accessibility and quality of these services for users.

When this will impact:

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Where this will impact:



6.8 Challenges and opportunities

Health and aged care

92. Challenge

Demand for health and aged care services and infrastructure is increasing due to our growing and ageing population, and rising incidence of chronic diseases. This is placing pressure on already stretched health infrastructure. Without action, our healthcare system will be unable to meet this demand and maintain quality, accessibility and affordability of services for communities.

When this will impact:



Where this will impact:



93. Challenge

The changing nature of health issues are driving up the cost of health infrastructure and services for both governments and users. If not addressed, government funding will become unsustainable and costs will become unaffordable for people, particularly those on lower incomes.

When this will impact:



Where this will impact:



94. Opportunity

New healthcare service models that improve in-home and preventive care can reduce hospitalisations. Embracing new models can alleviate pressure on hospital infrastructure, improving access and service quality for those who need it most.

When this will impact:



Where this will impact:



95. Challenge

Chronic condition, aged and end-of-life care infrastructure is not responding sufficiently to changing preferences for care at home or in community. Without action, this care will not be accessible, dignified, nor person centred for a growing number of Australians.

When this will impact:



Where this will impact:



96. Challenge

Young people with disability are often forced to live in inadequate or not fit-for-purpose facilities, including aged care and mental health facilities, due to a lack of purpose-built facilities for people with disability. If not addressed, young people with disabilities will continue to experience poor-quality care that does not meet their needs, and reduces their quality of life.

When this will impact:



Where this will impact:



97. Challenge

Low service densities can limit the provision of accessible, continuous and quality health care in rural communities and remote areas. Without action, healthcare outcomes for communities in these areas, particularly Aboriginal and Torres Strait Islander peoples, will continue to be adversely affected.

When this will impact:



Where this will impact:



98. Opportunity

Technological advancements are enabling health infrastructure to be more digitally-oriented, from patient care to record keeping and infrastructure management. Embracing new technologies has the potential to reduce time and distance barriers to accessing health care, and improve efficiencies and quality of care.

When this will impact:



Where this will impact:



99. Opportunity

The delivery of new and upgraded major health infrastructure in cities provides the opportunity to co-locate these assets with other services, such as other health services, research, education and community infrastructure. Creating health precincts could enable more integrated health care, with higher quality and greater accessibility for patients, and improve Australia's health research and education capabilities, attracting global expertise.

When this will impact:



Where this will impact:



Education

100. Challenge

Early childhood education services are delivered by a mix of public, private and not-for profit providers, creating fragmented infrastructure delivery and quality. Without action, continued variation in the quality of facilities may create poor educational outcomes for some children, and exacerbate challenges for parents in accessing and paying for services.

When this will impact:



Where this will impact:



101. Challenge

Demand for school infrastructure is increasing in our fast-growing and satellite cities, particularly in the inner city and outer growth areas of fast-growing cities. Without action, increased demand will create overcrowding in schools, and impact the quality of infrastructure and educational outcomes for students.

When this will impact:



Where this will impact:



102. Challenge

Traditional approaches to increasing the capacity of school infrastructure, such as using demountable buildings, are not adequate for the demand projected, nor necessarily appropriate for student outcomes. Maintenance backlogs and space constraints provide additional complexity. Without changes to the way demand is evaluated and new capacity provided, schools in fast-growing cities will be unable to meet growing demand, risking reduced quality of education outcomes for students.

When this will impact:



Where this will impact:



103. Challenge

Schools in some smaller cities, and rural communities and remote areas are facing reduced demand, as populations in these areas decline and age. Without action, these communities will be forced to reduce educational services and infrastructure provision, potentially resulting in fewer resources to provide rich and diverse curricula to students.

When this will impact:



Where this will impact:



104. Challenge

Much of Australia's school infrastructure is ageing and not fit for purpose for 21st-century learning. This includes a lack of flexibility to adapt to new technologies and teaching models, or buildings which are not accessible for all students. Maintaining and upgrading buildings is costly for governments and disruptive for learning outcomes, however without action, Australian schools risk falling behind other countries in preparing students for work and life in the 21st century.

When this will impact:



Where this will impact:



105. Opportunity

School infrastructure can provide essential community facilities and spaces, such as sporting fields and halls, however, access to school infrastructure is often restricted to ensure student safety and reduce maintenance costs for government. Harnessing the benefits of school infrastructure for community use outside of school hours, particularly in fast-growing cities where space is scarce, can improve the efficient use of education infrastructure assets and improve health and social wellbeing outcomes for people.

When this will impact:



Where this will impact:



106. Challenge

Demand for tertiary education infrastructure is increasing, particularly for universities in fast-growing cities, and for vocational training in smaller cities, and rural communities and remote areas. Without action, universities and vocational education facilities will experience overcrowding, impacting on the quality of student outcomes.

When this will impact:



Where this will impact:



107. Challenge

Access to vocational education infrastructure is a challenge in remote areas. Students often have to travel long distances to reach teaching facilities. Without action, reduced access to tertiary education will deliver poorer educational and economic outcomes for communities in remote areas, particularly those with high socio-economic disadvantage who cannot afford to travel and stay in other areas to study.

When this will impact:

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10-15

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Where this will impact:



108. Challenge

Competing priorities are reducing the focus on maintaining ageing assets in tertiary education infrastructure. Without action, students may experience poorer-quality learning outcomes.

When this will impact:

0-5

5-10

10-15

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Where this will impact:



109. Challenge

Tertiary education infrastructure is often poorly-integrated with other types of infrastructure, including transport and affordable accommodation. Without action, access to tertiary education infrastructure could be reduced for a growing number of students and employees, impacting more broadly on transport congestion and overcrowding, and potentially increasing costs for students.

When this will impact:

0-5

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15+

Where this will impact:



Green, blue and recreation

110. Challenge

Investment in green, blue and recreation infrastructure is often not prioritised because the true costs and benefits are not well-integrated into government decision making. Without action, essential green, blue and recreation infrastructure will not be delivered, reducing access for communities to spaces that improve liveability, health and environmental outcomes.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



111. Opportunity

Joint- and shared-use of recreation infrastructure can solve space constraints in fast-growing cities, and help to overcome lower demand and funding constraints in rural communities and remote areas. Sharing spaces and facilities can improve access for communities to high-quality infrastructure and bring down costs for users and operators.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



112. Challenge

Fragmented governance of green, blue and recreation infrastructure makes it hard to integrate into land-use planning. Without action, a lack of coordination for both planning and data could lead to a loss of critical green, blue and recreation infrastructure and inefficient use of existing spaces and facilities.

When this will impact:

0-5

5-10

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Where this will impact:



113. Challenge

In fast-growing cities, green, blue and recreation infrastructure is highly valued and overused. The high cost of land, operations and maintenance make it difficult to fund the delivery and maintenance of new infrastructure in these cities. Our fast-growing cities risk not having adequate high-quality, accessible green, blue and recreation infrastructure as they grow and densify, particularly in inner-urban areas.

When this will impact:



Where this will impact:



114. Challenge

In areas outside of fast-growing cities, green, blue and recreation infrastructure is often fragmented across multiple assets and expensive to maintain. Lower demand in these areas can make it difficult to fund the delivery, operations and maintenance of new infrastructure. High costs of maintenance for underused assets can create challenges in providing adequate high-quality green, blue and recreation infrastructure to support communities.

When this will impact:



Where this will impact:



115. Challenge

Green canopy cover is increasingly hard to provide in cities as backyards decrease and densification occurs. Without action, access to green space will diminish in our cities, and liveability will increasingly be affected by the urban heat island effect.

When this will impact:



Where this will impact:



Arts and culture

116. Challenge

Investment in arts and cultural infrastructure is often not prioritised because the true costs and benefits are not well integrated into government decision making. Without action, arts and cultural infrastructure will not be delivered, reducing access for communities to spaces which enhance liveability, creativity and help to create a sense of identity.

When this will impact:



Where this will impact:



117. Challenge

Governance of arts and cultural infrastructure is fragmented, resulting in a lack of comprehensive data on the scale and distribution of the sector. Without action, investment in the sector will not be prioritised, leading to poorer accessibility and quality arts and culture infrastructure for communities.

When this will impact:



Where this will impact:



118. Opportunity

Well-integrated arts and cultural infrastructure can enhance the value of other types of infrastructure, such as public transport or green infrastructure. Leveraging investment across other sectors by embedding arts and culture into land use and infrastructure planning will provide greater benefits to communities to access arts and cultural infrastructure.

When this will impact:



Where this will impact:



119. Challenge

The arts and cultural infrastructure sector varies across Australia, making it hard to address local needs, audiences, demand levels and funding. Traditional approaches to planning, delivering and maintaining arts and cultural institutions and programs do not always respond to local needs, requiring new approaches to improve access and quality for local communities and visitors.

When this will impact:



Where this will impact:



120. Challenge

Arts and cultural infrastructure suffers from maintenance backlogs, high costs of heritage maintenance, and space constraints, resulting in assets not being fit-for-purpose. Without appropriate long term planning and funding prioritisation, the quality and accessibility of these institutions for users will diminish.

When this will impact:



Where this will impact:



121. Opportunity

Arts and cultural infrastructure plays a key role in the social and economic empowerment of Aboriginal and Torres Strait Islander peoples. Leveraging investment in arts and cultural institutions to promote the collection and celebration of Aboriginal and Torres Strait Islander arts and cultural materials can provide wider socio-economic benefits to these communities, particularly in rural and remote areas.

When this will impact:



Where this will impact:



122. Opportunity

Digital technology offers new ways to access arts and cultural infrastructure, beyond physical assets. Harnessing technological advances and investing in ongoing maintenance and curation will improve accessibility to Australia's arts and cultural infrastructure, particularly for rural and remote communities located long distances from major institutions.

When this will impact:



Where this will impact:



Social housing

123. Challenge

There are limited pathways for people to move through the housing continuum, particularly from social housing into the private market. Without adequate affordable housing options for people on different income levels, people may remain in social housing for longer, occupying homes that could be provided to people in greater need.

When this will impact:



Where this will impact:



124. Challenge

Australia's social housing stock is not meeting current or projected tenant needs in terms of dwelling sizes and configurations, accessibility and supporting services. Without action, reduced access to adequate and high-quality housing can create adverse impacts on other aspects of peoples' lives, including their health, employment opportunities, educational attainment and broader wellbeing and life satisfaction.

When this will impact:



Where this will impact:



125. Challenge

Australia's social housing asset base is deteriorating and there is an increasing maintenance task, affecting the quality of dwellings. Failure to properly maintain dwellings can exacerbate maintenance costs and create negative health and well-being impacts for tenants.

When this will impact:



Where this will impact:



126. Challenge

Remote Aboriginal and Torres Strait Islander housing is not meeting the needs of communities, due to overcrowding and poor quality dwellings. Inadequate housing exacerbates the health, education and well-being outcomes of Aboriginal and Torres Strait Islander peoples, which are already below those of other Australians.

When this will impact:



Where this will impact:



127. Opportunity

The community housing sector is growing, supporting governments to deliver high-quality services to social and affordable housing tenants. Leveraging further growth in the sector can increase innovation in social and affordable housing delivery and management, and improve the quality of housing services for tenants.

When this will impact:



Where this will impact:



Justice and emergency services

128. Challenge

The location of justice infrastructure assets is misaligned with demand, due to population growth and urbanisation. If left unaddressed, this will result in reduced quality of, and reduced accessibility to our justice services, particularly correctional services.

When this will impact:



Where this will impact:



129. Challenge

Ageing justice infrastructure assets are not fit-for-purpose for changing user demographics and needs. Without changes to the design of justice infrastructure and services provided to adapt to changing types of users and needs, diverse users will experience increasingly poor quality services.

When this will impact:



Where this will impact:



130. Challenge

Our emergency services infrastructure is not adapting to changes in the nature and rate of emergencies. Without action, emergency services infrastructure which is not fit-for-purpose for the changing nature of emergencies will reduce access to life-saving services, particularly in rural communities and remote areas.

When this will impact:



Where this will impact:



131. Opportunity

There is a high level of interdependence between justice and emergency services, and with other sectors, such as health. The changing nature of crime and emergency events provides opportunities to improve coordination across sectors to deliver more holistic, and higher-quality services, and improve accessibility through approaches such as jointly-managed facilities and programs.

When this will impact:



Where this will impact:



132. Opportunity

Digital technology and operational changes are providing 'non-build' ways to improve justice infrastructure efficiency and service quality. Harnessing these advancements can reduce demand on existing physical infrastructure and improve the accessibility and quality of these services for users.

When this will impact:



Where this will impact:



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7

Energy

This chapter explores trends and issues in the stationary energy sector, including:

- Electricity generation, transmission and distribution networks, as well as forms of electricity storage, and retail issues that affect service provision
- Gas transmission and distribution infrastructure, covering the domestic market for energy
- Australia's oil and petroleum reserves.

For 22 million Australians – or 89% of the total population – electricity is provided by the National Electricity Market, covering the eastern half of the continent.¹ This market includes over 40,000 kilometres of transmission lines and cables, and supplies around 200 terawatt hours of electricity to users each year.² It is one of the longest interconnected electricity systems in the world, stretching from far north Queensland down to South Australia and across Bass Strait to Tasmania.

Beyond this grid, the Wholesale Electricity Market provides power in Western Australia, serving Perth and beyond. There are three smaller and separate networks in the Northern Territory, while many users in some areas, including Australia's external territories, have stand-alone electricity systems.

Australia's domestic gas market is split into three regions, in the east, west and north, based on the location of gas basins and pipelines that supply them. Wholesale gas is supplied to electricity generators and other large industrial users, as well as retail suppliers, who then sell it to businesses and households. Australia is connected to global markets via liquefied natural gas (LNG) export facilities, and is projected to be the world's largest exporter of LNG in 2019.³

Australia also holds reserves of oil, and there are four refineries in operation. We export most of the petroleum we produce, as most of Australia's oil is better suited to overseas refineries, and we import most of the oil and petroleum we consume.⁴





7.1 Introduction



The state of the energy sector

For many years, Australia has held a comparative advantage in energy costs, as well as an abundance of natural energy assets. This has propelled our economy, supporting improvements in the productivity of our businesses and helping us to compete in global markets. There are indications that this advantage is slipping, but Australia can overcome current challenges and spur a new wave of growth off the back of our energy resources and industry capability.

Much of Australia's energy infrastructure is fixed, costly and long-lived. Its markets are

highly complex and sensitive to change. These characteristics are adding to the challenges of a sector that is undergoing a transformation, adapting to new generation sources and consumer preferences. This energy transformation is occurring against a backdrop of climate change and ongoing policy uncertainty, with inadequate coordination across Australia's governments on how best to manage changes. The result has meant a poor deal for many users, with bills rising rapidly over recent years and most users expressing dissatisfaction with the affordability of their energy services.⁵



Our energy systems are well established

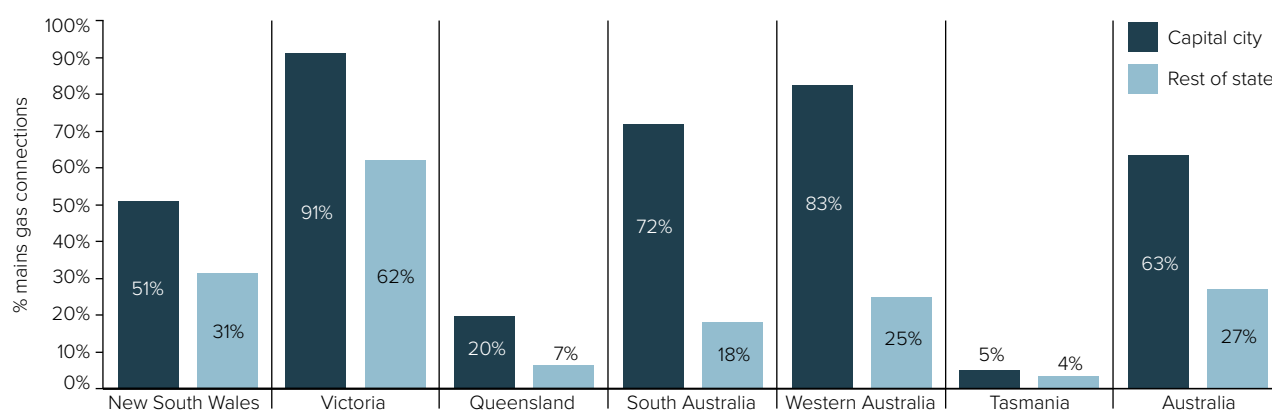
Over the last century, our energy systems have largely been one-way systems, connecting large and centralised sources of electricity generation and gas production outside our cities to household and business users. Transmission lines (for electricity) and pipelines (for gas) run to the outskirts of our cities and towns from centralised production sources. Smaller distribution networks branch out down our streets and highways to deliver energy to the houses and businesses that use it.

Two forms of energy are networked across Australia – electricity and gas. Neither is fully connected

across the mainland. Small customers make up 98% of electricity connections and 99% of gas connections.⁶ Gas connection rates vary widely by state and territory, and between cities and regions (Figure 1). Over 80% of Victorian households have a gas connection, compared to 5% in Tasmania. In capital cities, almost two-thirds of households have a gas connection, compared to just over a quarter of households elsewhere.⁷

Households only consume 25% of total grid electricity and 18% of our direct gas.⁸ The manufacturing, mining and the services sectors consume the vast majority of grid electricity and gas, underscoring the importance of energy to our productive base.

Figure 1: While almost everyone has an electricity connection, gas connections are more varied



Note: Capital city and rest of state breakdowns are not available for Australian Capital Territory and Northern Territory.

Source: Australian Bureau of Statistics (2014)⁹



Australia's electricity is provided through a range of separate systems:

- The National Electricity Market (NEM) brought together historically developed state-based electricity systems as a spot market of five regions in 1998. There are over 300 participants in the market, including generators of electricity, transmission and distribution service providers, and retailers that sell to a customer base of over nine million households and businesses. Electricity generation in the NEM represents over 80% of total electricity consumed in Australia.¹⁰
- The Wholesale Electricity Market (WEM) in Western Australia commenced in 2006. The WEM serves over one million customers,¹¹ and operates under different market rules to the NEM. The WEM supplies the South-West Interconnected System (SWIS), which serves the main population centres of south-west Western Australia, including Perth.¹² The other major system in Western Australia is the North West Interconnected System (NWIS) in the Pilbara. The NWIS generates and transmits electricity to local communities, as well as into major resource operations.
- The Northern Territory system is composed of three unconnected regulated electricity systems: Darwin-Katherine (serving approximately 150,000 customers), Tennant Creek (7,000 customers) and Alice Springs (28,000 customers). Most of the electricity consumed in the Northern Territory is from locally-produced gas.¹³

- Numerous small regions across Australia are not connected to any of the above systems, including small remote inland and coastal communities, islands near the Australian mainland and Tasmania and external territories. These rely on a mix of locally-generated, via diesel or solar photovoltaics (solar PV), or imported energy.

As with electricity, Australia's gas network has an eastern market that stretches from Queensland down to Tasmania and across to South Australia, and separate Western Australian and Northern Territory systems. Australia has evolved from a relatively stable, closed domestic gas market to the world's largest exporter of LNG in less than a decade.¹⁴ Overall, about 13% of the gas we produce is used to generate electricity domestically, and about 70% is now being exported.¹⁵ In late 2018, the Northern Territory and eastern networks were connected by pipeline between Tennant Creek and Mt Isa.

Oil is the largest source of energy consumption in Australia, accounting for 37.7% of all energy consumed.¹⁶ This is now mainly imported, and is chiefly an input into non-stationary energy via the transport sector, which consumes three-quarters of the total.¹⁷

The start and end points of our networks are changing

For generations, our cheap incumbent source of stationary energy has been black and brown coal, supported in small part by hydroelectricity and more recently, gas. The challenge of climate change, and concurrent technological change means that renewable energy sources are now effectively challenging traditional sources of energy on an economic basis.

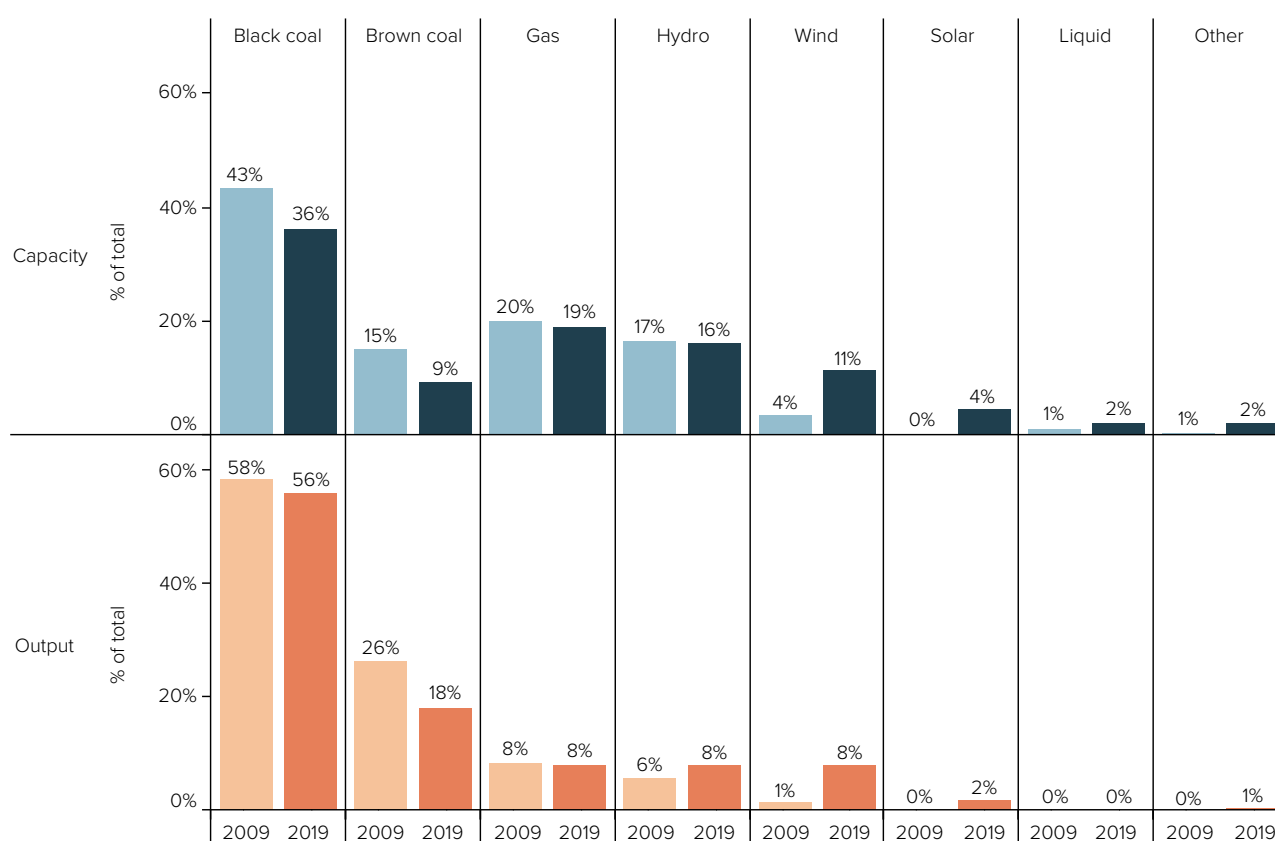
We are already seeing both globally and nationally a major shift towards new generation capacity being renewable versus fossil fuelled. According to the International Energy Agency renewable generation capital expenditure in 2017 was US\$298 billion compared with US\$132 billion for fossil-fuelled generation. In the same year, US\$17 billion was spent on nuclear generation – a 44% decrease from the previous year.¹⁸

The generation mix in the NEM is rapidly changing, as illustrated by Figure 2. Older coal-fired generators are retiring or approaching the end of their lives. At the same time, falling costs of rooftop solar PV

and storage, combined with government subsidies, are changing the way our electricity is generated and used locally. In 2018, one in five households had rooftop solar, and 21% of electricity over the previous 12 months came from renewable sources.¹⁹ This figure will continue to climb off the back of \$20 billion worth of investment in large-scale renewable energy projects in 2018 – twice that of the year before.²⁰ According to Australian Energy Market Operator (AEMO), Australia could have one of the highest ratios of decentralised non-grid generation in the world.²¹ By 2050, CSIRO and Energy Networks Australia estimate that between 30 to 45% of our annual electricity consumption could be supplied from consumer-owned generators.²²

The changing generation mix increases the intermittency of supply, meaning a requirement to move electrons from end users back into the grid. These changes present major challenges for transmission networks. Encouraging investment in new fuels in efficiently developed new fuel precincts – called Renewable Energy Zones (REZ) – may help to optimise investment in networks to support this transformation.

Figure 2: The generation mix in the NEM is shifting to include more renewables



Note: Generation capacity at 1 July 2018. Rooftop solar output estimates derived from CER data on installed capacity and AEMO system output assumptions. Other dispatch includes biomass, waste gas and liquid fuels. Storage includes only battery storage.

Source: Australian Energy Regulator (2018)²³

Energy affordability has become a major concern for users

The dominant issue in the energy sector since the last Audit has been the growth in energy prices. Over the past decade, the unit price of electricity has risen in real terms by 56%,²⁴ while retail gas for households has risen by 45% over the same period.²⁵ Many of the reasons for the spike in prices occurred prior to 2015 – including decisions to increase investments in electricity network assets, and to open the east coast gas market to global forces through the construction of new export facilities in Queensland.

However, in the years after 2015, wholesale electricity prices have risen steeply. This was caused by the closure of key coal-fired generation assets, issues with network reliability due to ageing assets, and rising costs for generation inputs such as coal and gas.²⁶

The impact of this steep climb in users' electricity bills has been a negative shift in user perceptions of affordability – with electricity seen as the least affordable form of infrastructure by Australian consumers,²⁷ and least likely to improve over the next five years.²⁸ This is despite energy costs not forming a large component of the average household expenditure, ranking behind transport and telecommunications costs.²⁹

Industry, including commercial activity, transport, construction, manufacturing, mining and agriculture, accounts for 89.2% of all Australia's total electricity and gas consumption.³⁰

For sectors more reliant on energy as an input to their processes, recent price increases place extra pressure on their operations. Recent energy productivity gains by business are being reduced by energy cost increases.

A key challenge is balancing the vital, but countervailing forces, of reliability, environmental responsibility and affordability. Users, who ultimately pay the cost of greater reliability, are rarely engaged in decisions about reliability levels. Improvements in reliability beyond the current standard of 99.998% are likely to come at substantial costs to users, which they may not be willing to pay.

Uncoordinated government responses have fuelled a desire among many consumers to take control of their costs by seeking to move off-grid. Taxpayers are being impacted by government decisions to back programs or projects that affect the shape of the grid, and which tend to discourage market-based investment decisions by the private sector.

Uncertainty in energy policy remains an issue

Concerns about uncertainty expressed by Infrastructure Australia in the 2015 Audit persist into this Audit. The National Electricity Market, and the institutions which support its operation, have continued in the absence of decisive federal leadership. As a result, uncertainty on energy or emissions policy remain. Retail reform has taken a back seat to settling future arrangements in the NEM as it transforms its input energy mix.

However, there have been some gains in spite of ongoing uncertainty. While it may have affected some investment decisions, it is clear that investment in renewable generation has continued, notwithstanding uncertainty over long-term policy settings to deliver international emissions commitments at least cost. In spite of this uncertainty, many households and businesses have made changes to improve their energy efficiency and decrease emissions.

Gas has become an increasingly important energy policy issue since the 2015 Audit. Rising prices have put decisions to open Australia's east coast gas market to global forces under the spotlight. The opening of an interconnector between the eastern and northern markets will help to free up capacity for supply to domestic users in southern regions. The AEMO forecasts that the gas supply-demand balance is likely to remain tight into the next decade, with gas production in southern Australia continuing to decline, and supplies from Queensland limited by pipeline capacity.³¹

Australia could become a new energy superpower

Australia is endowed with tremendous energy potential. It should be a source of economic advantage for Australia, supporting our industrial base, jobs and national income. We have a great wealth of both traditional (generally non-renewable) energy and renewable energy.

As the world gradually transitions its energy fuel mix towards lower emitting technologies for domestic electricity production, Australia has an opportunity to take advantage of this transition as an even greater export opportunity, while concurrently returning Australia to its position as a low-cost energy producer.

As well as continued development of opportunities to benefit from our abundance of traditional energy sources, there are considerable opportunities for growth in renewable generation arising from our abundance of solar and wind energy. Australia could play an increasingly important role as a provider of renewable energy to our neighbours through direct electricity exports, or to global energy markets by exporting energy as hydrogen – a fledgling industry at present.

In this chapter

This chapter identifies challenges and opportunities facing energy infrastructure through users' eyes. It is framed around the four outcomes identified by Australia's Chief Scientist, Alan Finkel AO in 2017: increased security, future reliability, rewarding customers and lower emissions. The chapter also looks more broadly at Australia's changing energy mix, the balance between domestic consumption and export demand for our resources, the needs of users in remote areas, and how consumers are playing an increasingly important role in a traditionally 'top-down' infrastructure service sector.

7.2 Affordable and competitive energy looks at the first component of the Finkel Review – affordability. This includes how different groups of consumers and businesses view and are impacted by electricity and gas price rises that have outstripped inflation. We identify the infrastructure-related components of affordability, and discuss how better information can help consumers manage their grid energy costs.

7.3 Secure, reliable and sustainable energy looks at the remaining three components of the Finkel Review, with a focus on electricity reliability, different customers' willingness to pay, meeting climate policy commitments, and improving system resilience and security.

7.4 Transitioning to Australia's future energy fuel mix discusses Australia's short and longer term fuel market transition. The section also explores the challenges faced by each fuel and the effect of new forms of generation.

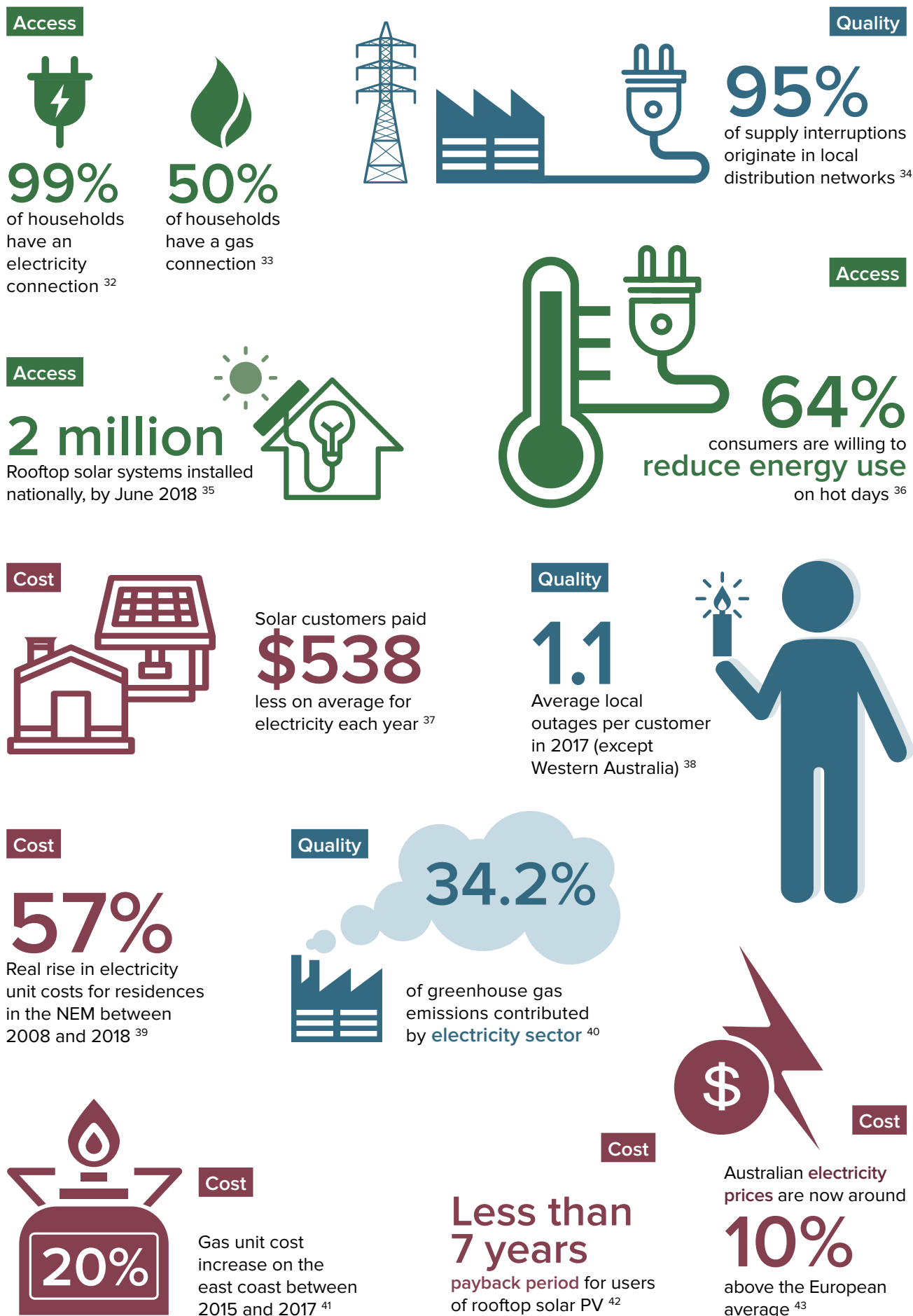
7.5 Planning our future energy networks considers the ability of existing governance structures to manage, and lead, through the ambiguity of the timing of the withdrawal of existing large generators and their replacement with new technology.

7.6 New opportunities for consumer choice considers the role of cheaper solar PV and storage in providing choice for consumers. The costs to the community of increased solar PV adoption and the challenges of integrating technology are also explored.

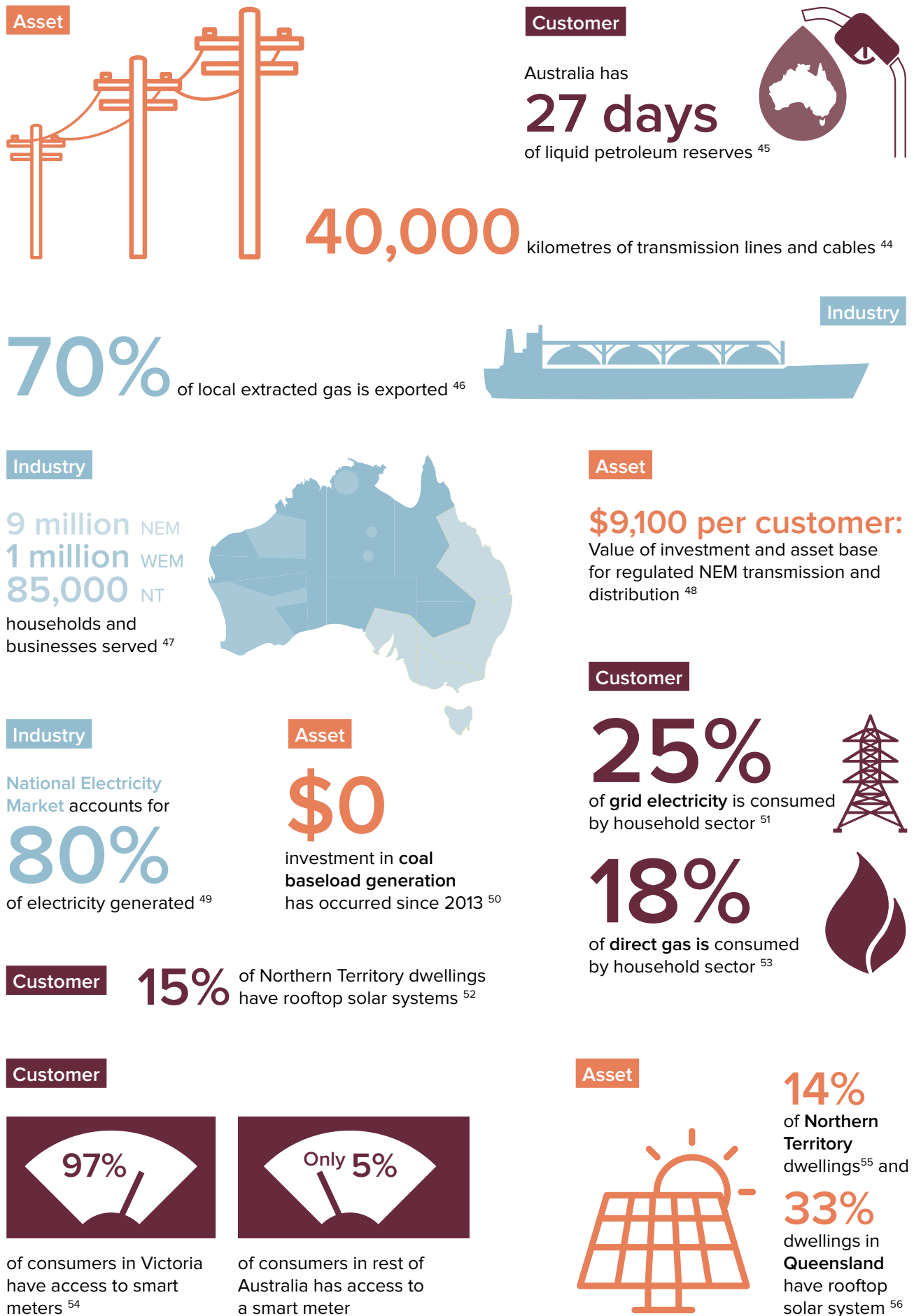
7.7 Delivering energy in remote communities discusses the costs and reliability of electricity provision in rural and remote areas. The section considers new technology and opportunities to better meet rural and remote users' energy needs.

7.8 Harnessing Australia's energy advantage considers some of the opportunities we can capitalise on to deliver Australia's potential as a new energy superpower.

Performance of the sector



Scale of the sector



7.2 Affordable and competitive energy

At a glance

Users are unhappy about their energy bills, with prices rising faster than inflation due to pressure on networks and generators. While most of this rise is linked to energy networks and generation, users are also paying for the move to new fuel sources.

Our cost of energy is rising faster than in many other countries, making us less competitive and undermining potential growth in productivity and investment.

Energy costs are front of mind for many

Many Australians are concerned about the affordability of energy.

In a survey undertaken for Infrastructure Australia, respondents rated electricity as the worst of all infrastructure sectors for affordability.⁵⁷ Over 60% of consumers see electricity as 'very costly' or 'costly', as shown in Figure 3. Figure 4 shows that gas also rates poorly for perceived affordability, with 38% of respondents seeing these services as 'costly' or 'very costly'. Consumers are also pessimistic about affordability in the future, with only one in 10 consumers expecting an improvement over the next five years.⁵⁸

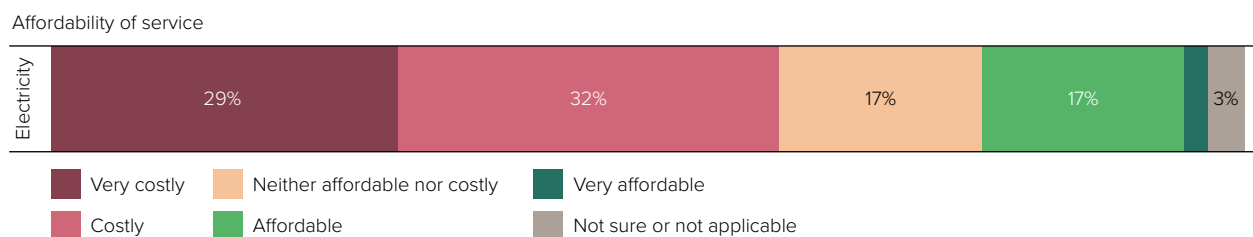
Despite Australians perceptions of energy affordability, average energy costs (about 3% of total household spending or \$40 per week) are still relatively small when compared to transport costs (about 15% or \$205 per week), and around the same level as telecommunications (about 3% or \$45 per week).⁵⁹

Bills have risen considerably over recent years

Much of this perceived lack of affordability is likely to be driven by recent price increases. While Australians used 8% less electricity per capita over the period 2003-04 to 2015-16, electricity bills rose by 30% in real terms, and gas bills rose by 37% over the same period.⁶⁰ Many households have seen their costs jump even more substantially over recent years, putting increasing strain on household budgets.⁶¹

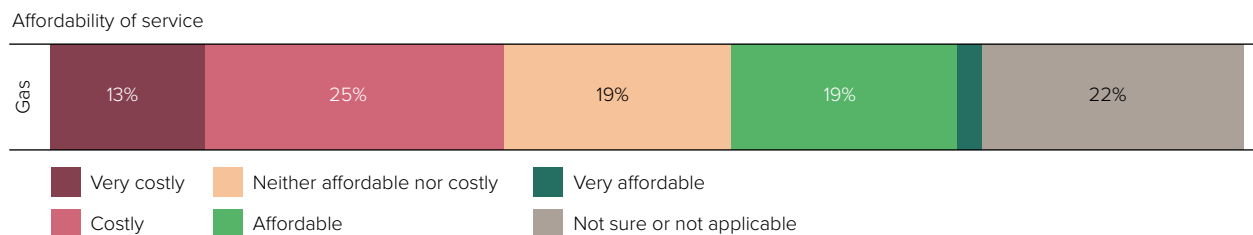
Household energy costs across Australia have grown faster than inflation in the past decade. However, as shown by Figure 5, this growth has not been equal, with cost increases faced by average customers in most of the NEM outpacing observed trends in Perth and Darwin. A significant part of the reason for this is due to price-setting and a taxpayer subsidy by the Western Australian,⁶² and Northern Territory Governments.⁶³

Figure 3: Electricity is perceived as the least affordable form of infrastructure, with over 60% of consumers rating it as 'costly' or 'very costly'



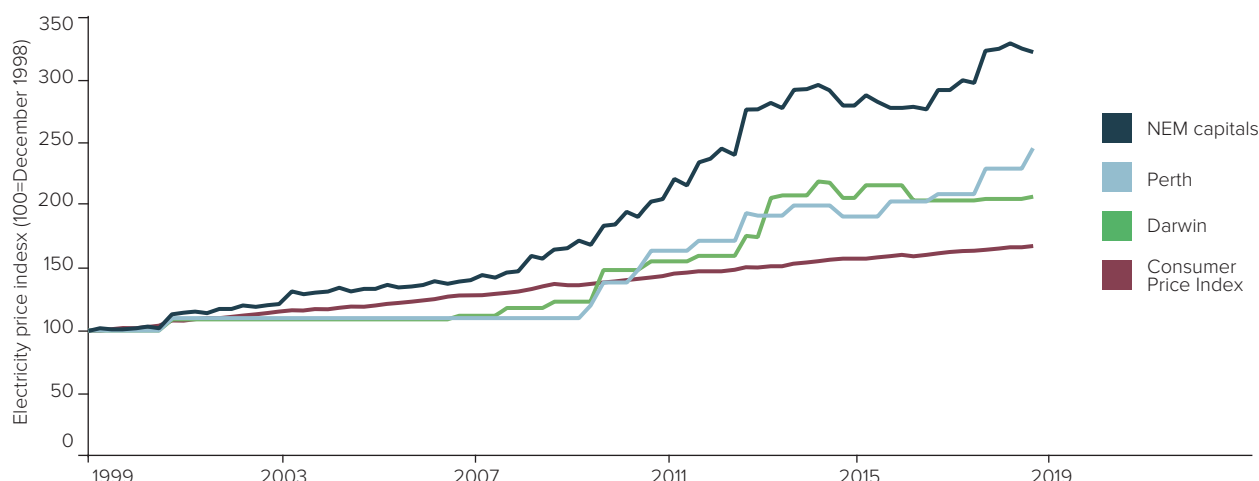
Source: JWS Research (2018)⁶⁴

Figure 4: Affordability is also an issue with consumers of gas services



Source: JWS Research (2018)⁶⁵

Figure 5: Electricity costs have risen much more than general inflation in the last decade, but costs in Perth and Darwin have risen less than in the NEM capitals



Note: NEM capital city index is unweighted.

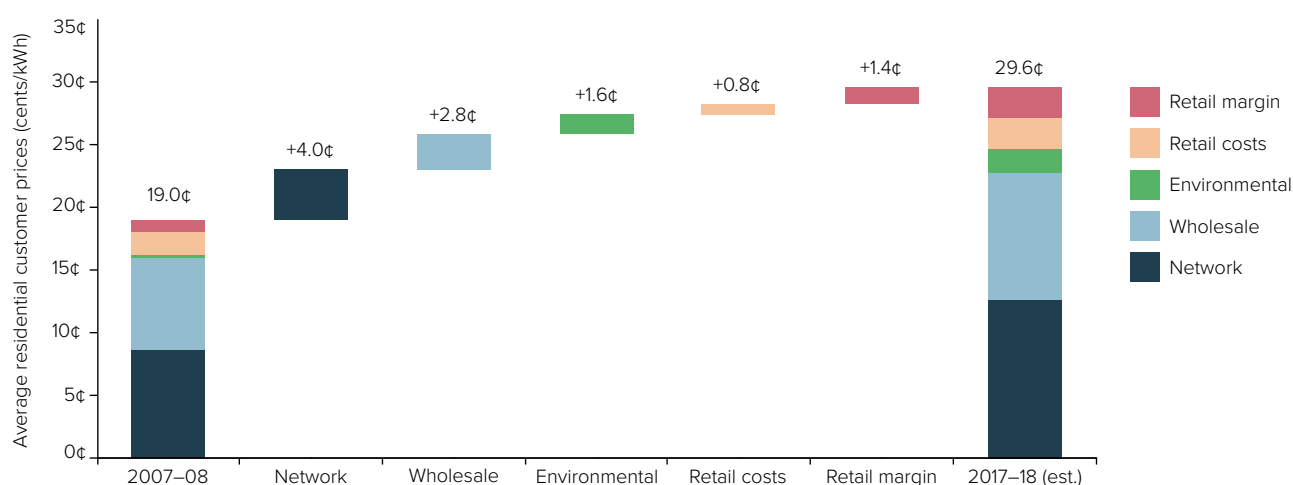
Source: Australian Bureau of Statistics (2019)⁶⁶

Network and generation costs have driven electricity bill rises

For the National Electricity Market, the unit cost of electricity rose 56% in real terms, on average, over the past decade. However, consumers have also used less electricity over this period, meaning that the impact on household bills has been lower, but still substantial – 35% in real terms.⁶⁷ Much of the decline in demand was due to improvements in energy efficiency and more households with rooftop solar.⁶⁸ However, there is also evidence that people on low incomes have responded to price rises by rationing their energy consumption, to the detriment of their health and wellbeing.⁶⁹

As shown by Figure 6, increases in network costs are responsible for the largest share of household price increases. Much of this stemmed from an increase in the NEM-wide regulated asset base from \$50 billion in 2006 to \$87 billion in 2017 (in 2017 dollars) – an increase of 75% in real terms.⁷⁰ Despite this increased expenditure, customers received decreasing value for money as the relative productivity of electricity networks decreased over the same period.⁷¹ A report by the Grattan Institute estimates that up to \$20 billion of investment in power networks was excessive, and that poor decisions by state governments in New South Wales, Queensland and Tasmania mean that consumers in those states pay between \$100 and \$400 more as a result.⁷² The scale of growth in asset bases and capital costs per users is illustrated in Figure 7.

Figure 6: Network and wholesale costs are the two largest drivers of NEM price rises



Source: Australian Competition and Consumer Commission (2018)⁷³

Figure 7: Per customer, the NEM regulatory asset base has increased while network investment has fluctuated



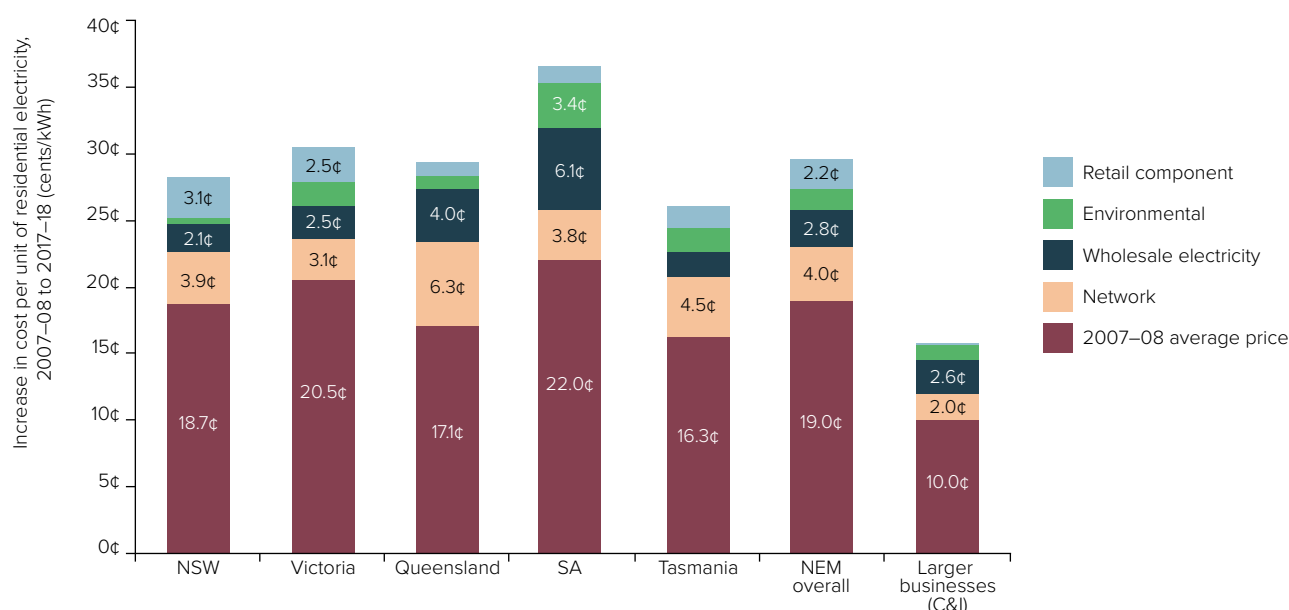
Source: Australian Energy Regulator (2018)⁷⁴

An increase in wholesale costs also caused a rise in bills for customers in the NEM, with costs rising sharply in the three years from 2014-15. Despite being offset by a decline in the cost of renewables, wholesale cost rises were due to a range of factors, including the retirement of major coal generators in South Australia and Victoria, a series of outages in ageing gas and coal generators, and interconnector constraints,⁷⁵ as well as higher gas and coal prices.⁷⁶ Generator rebidding – or ‘gaming’ of the market – was found to have added \$243 million in wholesale price spikes in 2017.⁷⁷

While environmental costs have also added to bills over the past decade, their direct contribution to cost increases is smaller than wholesale and network costs.⁷⁸ These are generally in the form of obligations placed on energy retailers to meet federal or jurisdictional policies.

Examples of these policies are the federal Renewable Energy Targets (RETs). These are the large- and small-scale schemes that require retailers to source a proportion of energy provided from renewable sources. The large scheme incentivises investment in large-scale renewable energy generation (initially wind but increasingly solar), and the smaller scheme subsidises household rooftop solar electricity and solar water heating systems. Several jurisdictions also have additional RETs.⁷⁹ There are also several dozen separate energy related incentives, rebates, grants and programs across states and territories, which include taxpayer support including for solar PV and battery installation, hot water systems, energy efficiency for households and businesses.⁸⁰

Electricity price impacts have varied across different parts of the NEM and for different customers, as shown by Figure 8. These differences over the past decade reflect different population densities, fuels, and state policies that exist across the eastern market, and the ongoing constraints in electricity flow between these regions.

Figure 8: Across the NEM, reasons for price increases over the past decade vary by jurisdiction

Note: Values are inflation adjusted to 2016-17, excluding GST.

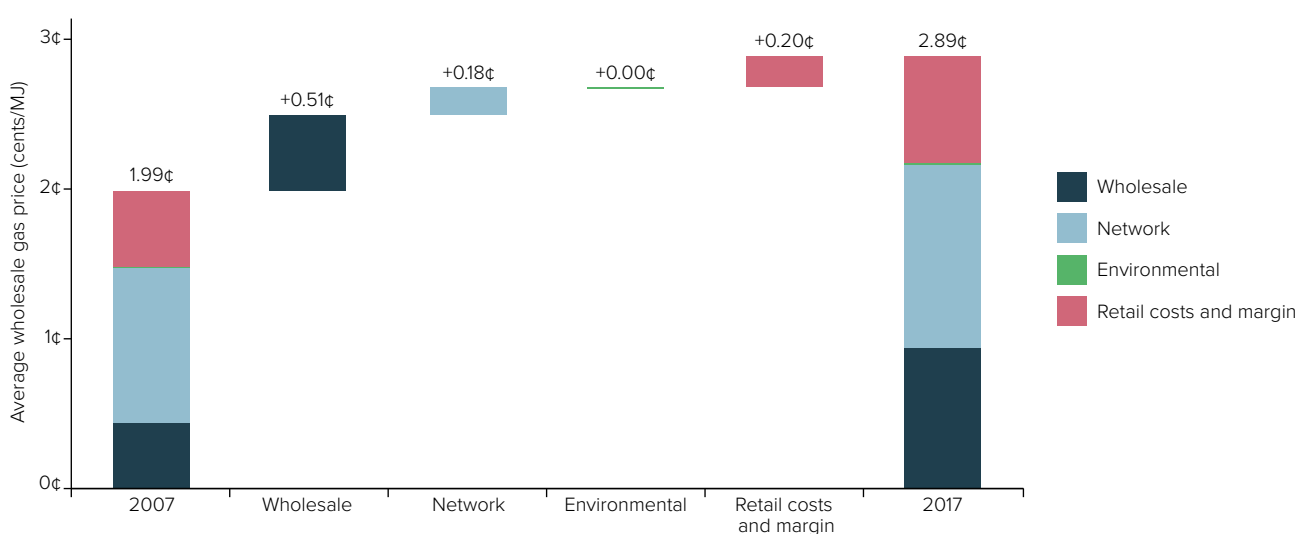
Source: Australian Competition and Consumer Commission (2018)⁸¹

Rising gas prices have added to cost of living pressures

Household gas costs have also exceeded inflation over the last decade, driven by a 46% rise in the unit gas price over the decade to 2017.⁸² This has largely been caused by a change in supply conditions for gas, following the ramp up of export volumes through the port of Gladstone. This has coincided with reducing Bass Strait volumes, and ongoing onshore gas supply constraints. Taken together, the wholesale price of domestic gas in east coast markets has substantially increased, as shown in Figure 9.⁸³

In Western Australia, the opposite has occurred, with wholesale prices falling since a high in 2009. However, price reductions in recent years have been confined to large industrial users rather than households.⁸⁴

However, household gas connection rates vary significantly across jurisdictions. For those with large gas distribution networks providing gas to residential customers, like Victoria, households are more significantly exposed to changes in the gas price, but relatively less affected by changes in the electricity price.

Figure 9: East Coast wholesale gas costs have been the main reason for gas price rises in the NEM

Source: Australian Energy Regulator (2018)⁸⁵



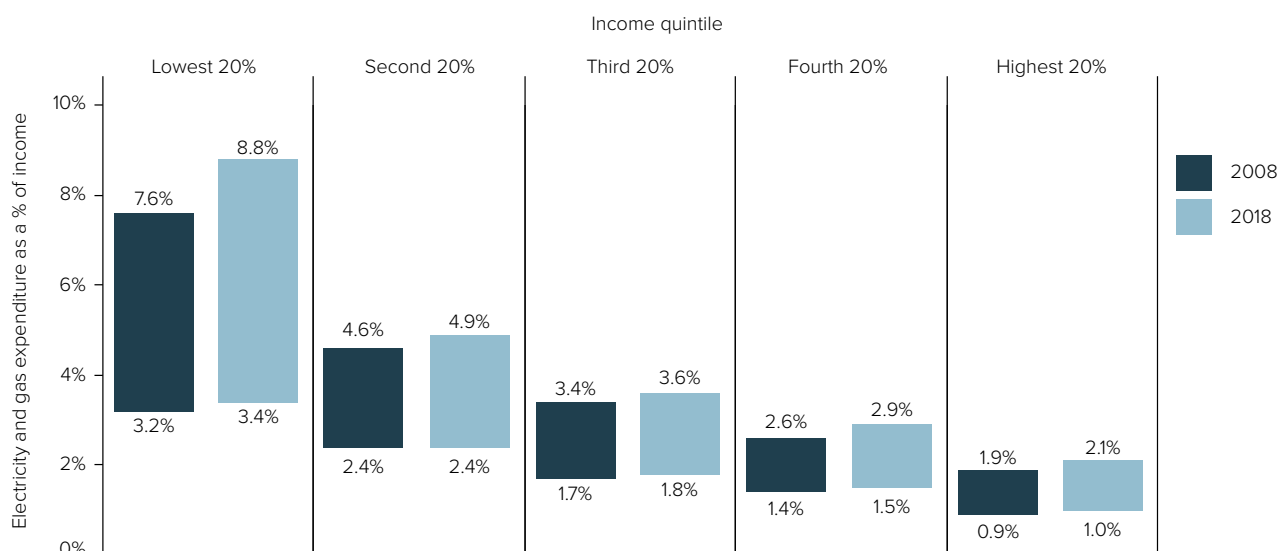
Energy costs are hard to avoid and are bigger parts of some household bills

Energy bill rises are hard to avoid for most users. Many households use a mix of gas and electricity for cooking and heating, while many businesses rely on gas for production, particularly as part of heavy industrial processes. Although electricity and gas are energy substitutes, most users have little capacity to switch between electricity and gas as their applications are fixed. Compounding this, a fall in the price of wholesale gas can increase demand for gas by centralised electricity generation, offsetting any potential savings for households and businesses that use gas.

For households, the cost of energy is hard to avoid or replace, and in many cases difficult to reduce with efficiency measures. Also, energy costs hit some of the most disadvantaged households hardest. Over the past 10 years, this impact has become even more regressive. Customers in the lowest income quintile have seen a greater increase in the proportion of their total income spent on energy than they spent 10 years ago, relative to all other energy users, as shown by Figure 10.

Notably, this was found to be the case after subsidies were taken into account, reflecting the regressive nature of essential services generally. Low income households are less likely to have efficient appliances, and those inefficient appliances are more likely to be used for heating or cooling a poorly insulated home.

Figure 10: Energy costs over the past ten years have become even more regressive



Note: Top value represents costs for households in 75th percentile, bottom value represents costs for households in 25th percentile.

Source: Australian Council of Social Service (2018)⁸⁶

Market complexity adds to user costs and frustration

For the energy market to work well, users must be able to understand their current bill, find the retail offer most appropriate for them and switch retailers with confidence. However, energy retailers have added to poor outcomes for users through confusing pricing structures, opaque discounting and effective penalties for loyal customers.⁸⁷ A lack of transparency in bills has also added to frustration as many users are unclear whether rising costs are due to their usage or changing costs of supply.

This has left many customers paying more than they should. Despite consumers being more empowered in their energy choices and having more retail options than previously, 37% of customers have not searched for a better offer in the last 12 months, with even fewer actually taking one up.⁸⁸ Only 20 to 40% of customers that have been with a major retailer for more than three years are on offers equivalent in value to a new customer, though this may have improved following public awareness campaigns and subsequent commitments made by retailers in 2017.⁸⁹

Some initiatives are underway to improve clarity of offers, including a consumer data right and a regulator-set standard default offer.⁹⁰ The Australian Government, through the Australian Energy Regulator, also launched the *Energy made easy* website to allow users to more easily compare energy offers in their area.⁹¹

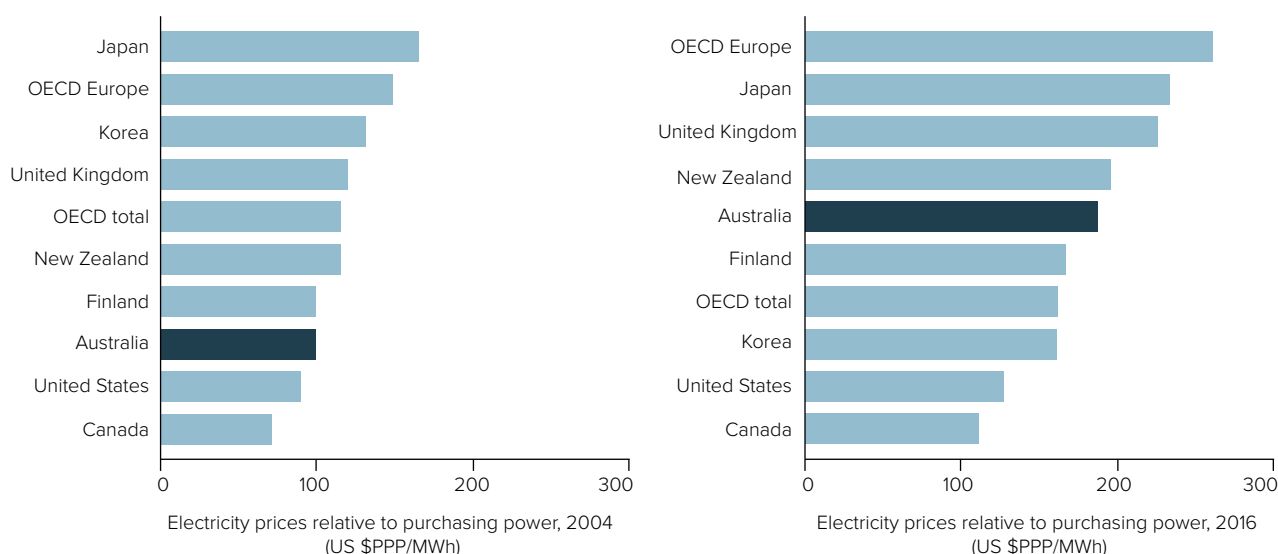
The economic consequences of higher energy costs are significant

The price of energy in Australia has risen compared to other nations. While Australia has held a strong advantage over many of its competitors through relatively low costs for energy, this advantage has eroded over recent decades, and we have slipped behind a number of other OECD nations, as shown in Figure 11. Given the wholesale cost increases experienced in the NEM since 2016, it is likely that Australia's position will have become less competitive than shown here.

Offsetting energy bill rises has been a 20% improvement in our energy productivity – that is, economic output per unit of energy – over the past decade.⁹²

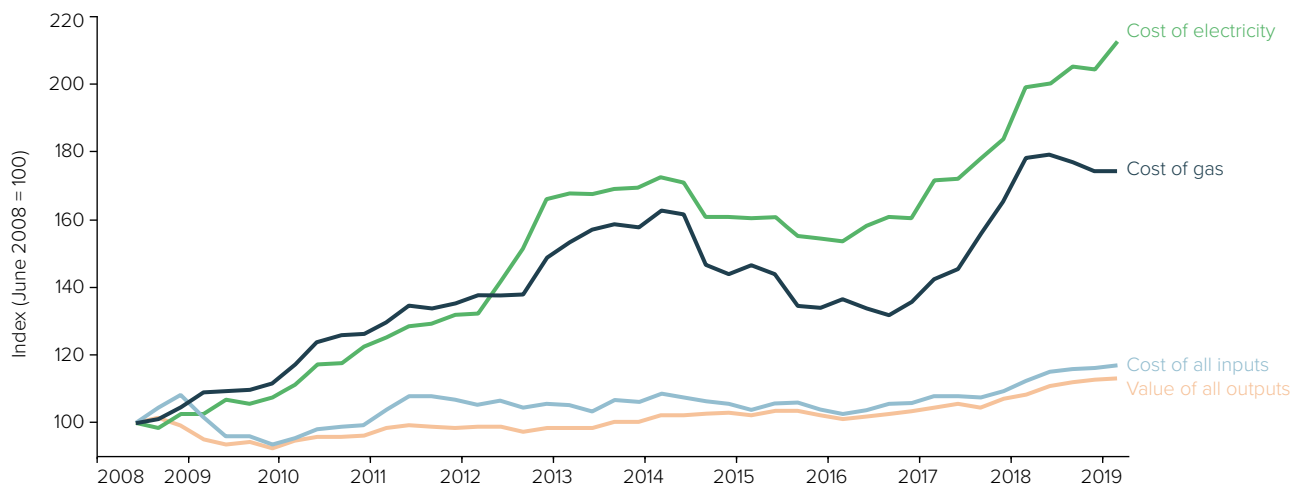
However, the recent jump in energy prices for industry are potentially outstripping energy productivity gains.⁹³ A permanent 10% rise in the wholesale cost of both electricity and gas could cost Australia over 13,000 jobs and reduce GDP by over \$8 billion.⁹⁴ Some businesses have seen a 56% real increase in electricity costs over the decade (Figure 12)⁹⁵ and significant gas price rises, so there is potential for this trend, if sustained, to be a disruptive influence on business output.

Figure 11: Australia is losing its energy advantage against comparable nations



Source: Australian Competition and Consumer Commission (2017)⁹⁶

Figure 12: Energy costs for key industries are rising, working against productivity gains



Source: Australian Bureau of Statistics (2018)⁹⁷

133. Challenge

Transparent and affordable electricity prices are essential to reducing pressure on household budgets, particularly for lower income households. A continued rise in energy bills will place an added burden on many households and may reinforce inequality. Ongoing complexity of bills will add to user costs and frustrations.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



134. Challenge

Regaining energy price competitiveness is important for lower business costs and improving productivity of Australian firms. Australia risks becoming uncompetitive in some energy intensive industries due to rising energy costs.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



7.3 Secure, reliable and sustainable energy

At a glance

This section looks at how our reliability and security standards affect investment. Power outages can have severe consequences, but preventing them is costly. Suppliers pass that cost on to users.

We review the impact of climate change, and how uncertainty about long-term energy and emissions policy has further raised user costs. We also discuss cyber security and our obligations under the International Energy Program Treaty.

Consumers rate the quality of energy services highly

Most energy users receive reliable services. This was reflected in the results of a survey for Infrastructure Australia, in which the majority of users rated the quality of our electricity networks and services as good, with only 11% rating it as poor (Figure 13).⁹⁸ Perception of quality of gas networks and services was similar, although more users were unsure – an indication that they did not have a connection. This contrasts with users' negative perceptions of affordability.

There is a trade-off between electricity reliability and affordability

The consumer message is clear – people are generally content with their energy supply, but think the price – especially for electricity – is too high.

However, quality (which we link to supply interruptions) and affordability are linked. The Finkel Review into the future security of the NEM posited that Australia was facing a trade-off which included addressing affordability,⁹⁹ whilst also meeting reliability and security expectations and delivering on Australia's international climate change commitments.

Maintaining a reliable and secure supply of energy, and doing so affordably, means understanding the risks and planning wisely to mitigate those risks. It also means understanding the value that customers place on reliability, and therefore the amount they are willing to pay for investment in infrastructure to mitigate risks to supply.

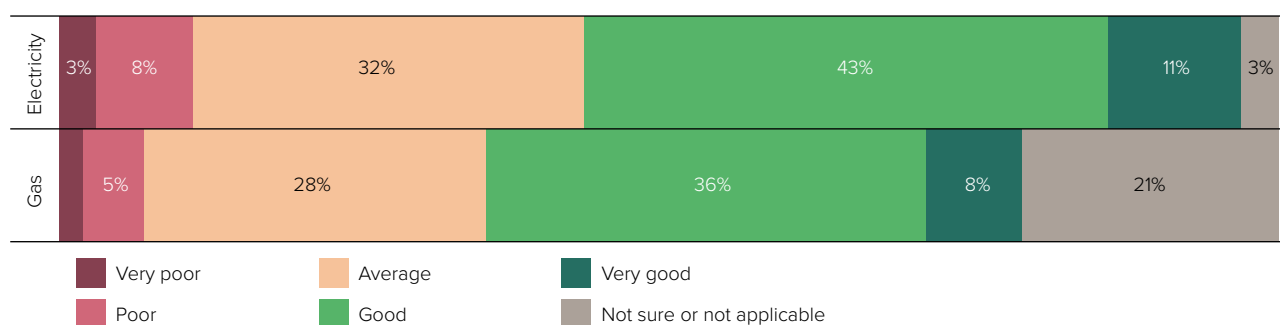
The reliability of Australia's electricity supply compares favourably with other countries.¹⁰⁰ Canada is perhaps the best comparison to Australia in terms of area, population density, settlement and fuels. Canadian customers experienced 18% more time per year with outages than Australians.¹⁰¹

Where reliability issues have occurred, these have been largely due to local factors, rather than a lack of generation capacity. Of the interruptions to power supply in the NEM over the past decade, 95% occurred in the local distribution system, and only 0.23% of interruptions were due to lack of generation capacity.¹⁰² Across the NEM and the Northern Territory systems, the annual electricity outage duration per customer per year has been falling over the past decade.¹⁰³

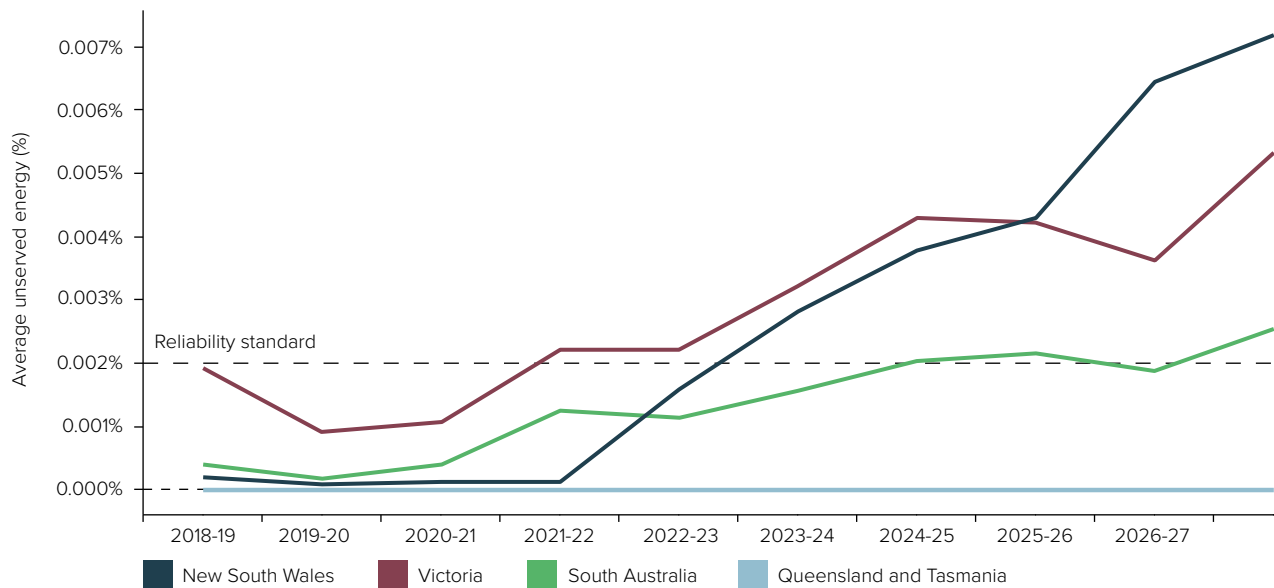
Importantly our electricity system is not expected to be 100% reliable 100% of the time. To demand this would increase energy costs dramatically, and exacerbate many of the affordability issues discussed earlier. Each advanced energy market establishes a reliability standard for its electricity system. In Australia this is measured as the number of instances of unserved energy (USE) with the standard being 0.002%.¹⁰⁴ AEMO predicts that the number of times the USE standard will be breached over the next 10 years will increase, as shown by Figure 14.¹⁰⁵

Figure 13: The quality of electricity and gas services is seen by most users as good

Quality of service



Source: JWS Research (2018)¹⁰⁶

Figure 14: Forecast unserved energy in the NEM is projected to increaseSource: Australian Energy Market Operator (2018)¹⁰⁷

Customer willingness to pay for reliability varies

Users have different levels of risk, and different willingness to pay, so striking a community-wide balance between reducing and tolerating risk is a complex task. Work is underway to better integrate consumers' willingness to pay to reduce risk, as a means of better measuring the case for additional investment.¹⁰⁸ The Australian Energy Regulator (AER) has recently started a review of the value customers place on reliability, and how this varies across

different regions and different customer types.¹⁰⁹ This review will update estimates AEMO developed for the NEM in 2014 (Figure 15).¹¹⁰

Across each state and territory, up to 64% of consumers surveyed by Energy Consumers Australia in 2018 said they were willing to reduce their energy usage at times of very hot weather (Figure 16). The responses varied across states and between household and business customers, providing insight into different consumer appetites for trading inconvenience for cost.¹¹¹

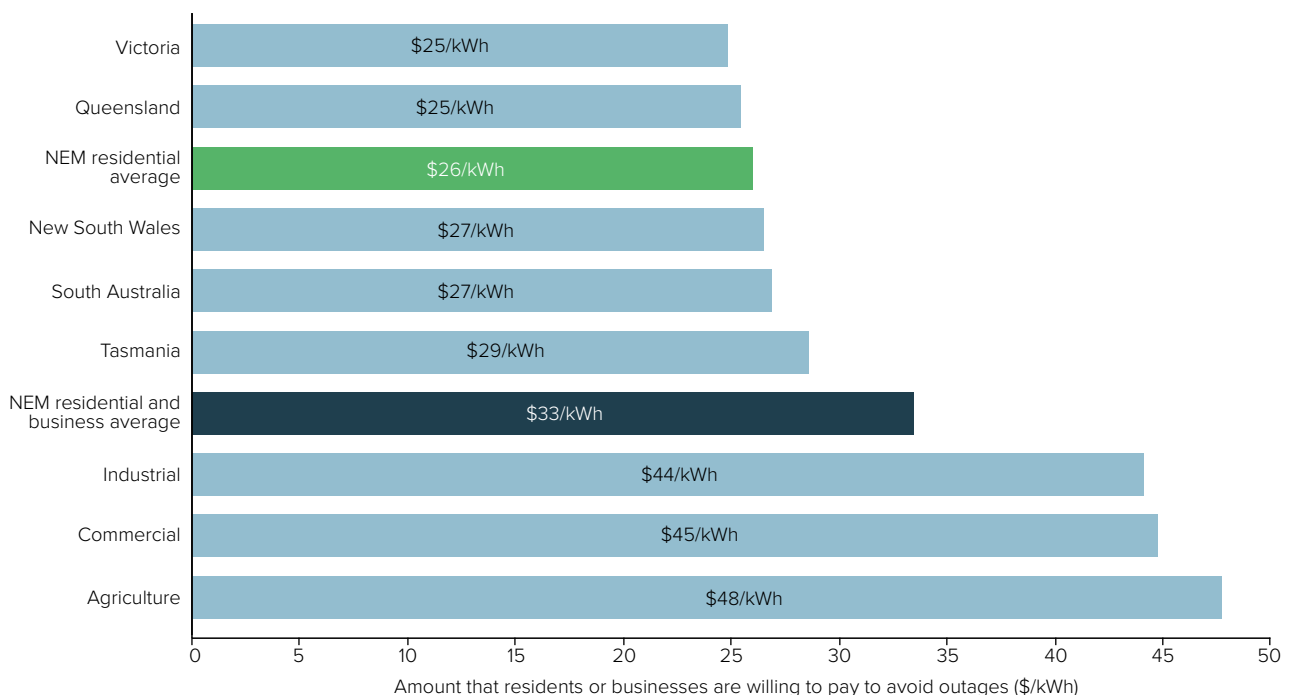
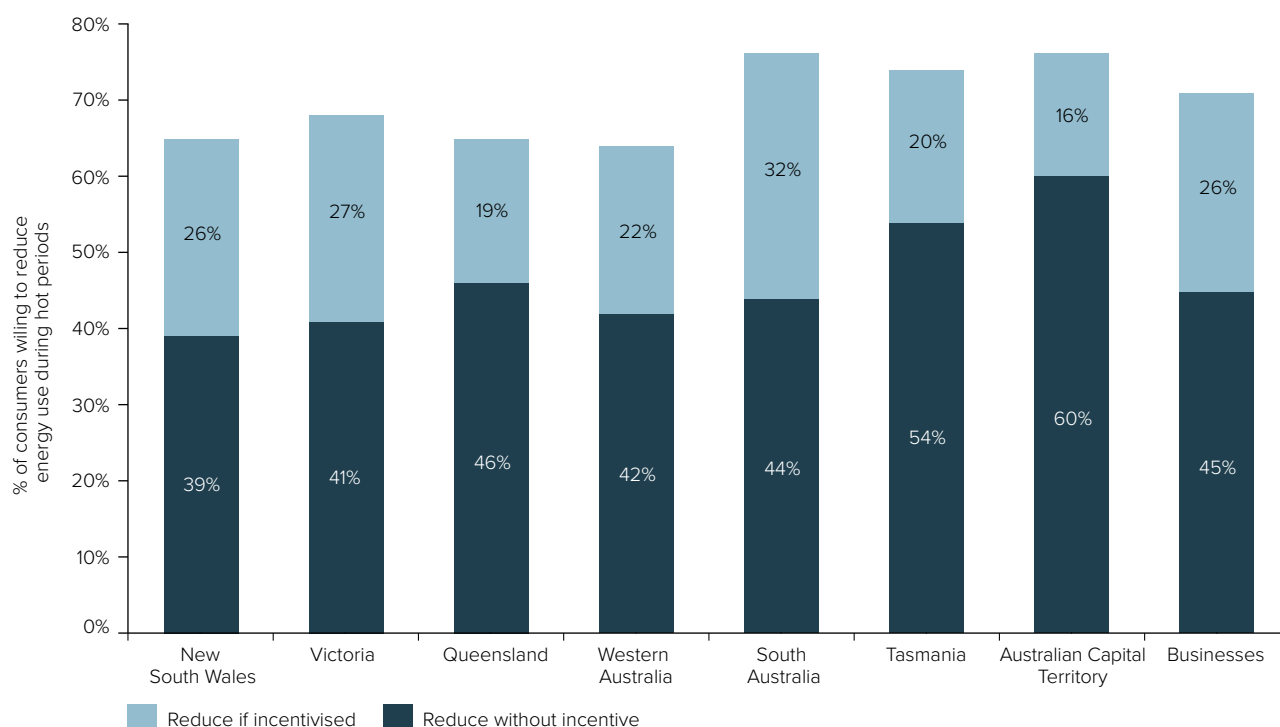
Figure 15: Willingness to pay to avoid electricity outages varies between regions and customer typeSource: Australian Energy Market Operator (2014)¹¹²

Figure 16: Energy Consumers Australia's survey shows consumers' willingness to act to reduce peak demandSource: Energy Consumers Australia (2018)¹¹³

135. Challenge

Balancing reliability and affordability in line with users' willingness to pay will be an ongoing challenge in energy systems with rapidly transforming wholesale and network characteristics. Failure to get the balance right will result in higher costs for users due to inefficient investments, or poorer reliability for users.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Energy systems face emerging risks that could impact reliability

Energy systems face a range of risks, many of which have emerged over recent years or are continuing to evolve – including risks from climate change and cybersecurity.

In particular, climate change is expected to increase the frequency and severity of extreme weather events. This will impact on the reliability and security of the energy system, and increase costs over time. The CSIRO, Bureau of Meteorology and AEMO have identified key future climate-related risks, including:

- Increased demand during more frequent hot days and prolonged heat waves
- Increased bushfire risk to system assets
- Changing rainfall patterns affecting hydro generation, and availability of cooling water for thermal generation
- Changing wind speeds impacting wind generation and transmission infrastructure.¹¹⁴

Another consequence of our increasingly interconnected world is the cybersecurity risks to our critical infrastructure systems from foreign and domestic attacks. This issue was explored by the AEMO in 2018, in response to a recommendation of the Finkel Review. This identified opportunities to improve cybersecurity risk mitigation, including collaboration within the industry and consideration of potential regulatory models to strengthen AEMO's authority to manage cyber security risk.¹¹⁵

Australia faces some risks to fuel security

Beyond the electricity and gas systems, Australia requires reliable and secure reserves of oil. As a signatory to the International Energy Program Treaty, Australia is required to hold oil stocks equivalent to at least 90 days of the previous year's net imports.¹¹⁶ Australian total petroleum reserves, measured as days of consumption cover, were estimated at 27 days at current consumption levels as at October 2018.¹¹⁷

Australia has been non-compliant since 2012 and is the only significantly non-compliant Treaty member.¹¹⁸ However, Australia has not experienced a supply disruption in 40 years, and currently imports oil from 21 countries. A move to greater electrification of transport vehicles over coming years, as well as a declining reliance on diesel generation in the resources and manufacturing sectors, and by remote communities, will mitigate some risks through decreased reliance on oil. Nevertheless there is low-risk, high-consequence potential for geopolitical events to broadly impact physical movement of oil.

The Australian government is working with the International Energy Agency to return to treaty compliance by 2026 in a phased approach.¹¹⁹ The cost of acquiring the oil stock shortfall has been estimated conservatively at over \$7 billion.¹²⁰ If Australian stock increases, it will likely trigger the need for new storage and processing facilities, at additional cost. There would also be costs associated with maintaining and testing diesel, as it degrades when stored over six months.

136. Challenge

Governments, regulators, operators and service providers need to manage growing risks to Australia's energy systems and fuel sources, including risks from climate change, cyberattack or disruptions to fuel supply. Failure to effectively mitigate against risks to energy services could have substantial consequences for the economy.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Lack of certainty on emissions policy is an ongoing challenge

Just as there is a trade-off between reliability and affordability, so too does sustainability require a balance of other energy objectives. In the absence of a settled policy to deliver on Australia's 2030 international commitments and the role of energy within it, uncertainty risks further driving up costs.

Electricity and gas are two of Australia's three largest emitting industry sectors,¹²¹ and their decarbonisation will be central to Australia meeting its international commitment to reduce emissions to 26-28% below 2005 levels by 2030. The electricity sector is on a decarbonisation path, with new renewable capacity displacing higher emissions from generation. As our gas export industry grows, emissions from the direct combustion of gas for energy (including at LNG plants) are rising.¹²²

Despite several iterations of a national emissions policy being proposed following the abolition of Australia's carbon pricing regime in 2014, the Australian Government did not settle on a policy for managing emissions until the release of the Climate Solutions Package in February 2019. The major energy regulators, led by the Energy Security Board,¹²³ the business sector, led by the Business Council of Australia,¹²⁴ and consumers, as represented by Energy Consumers Australia,¹²⁵ have all called for greater certainty on emissions and energy policy.

In the absence of a firm national policy, there is also an overlay of state policies to reduce emissions. Table 1 illustrates the range of Renewable Energy Targets committed to by each jurisdiction. These are generally state-based emissions targets, although New South Wales has a transmission infrastructure strategy focused on assisting the transition to

low-emission generation sources.¹²⁶ Individual climate and territory targets and subsidies within the NEM risk suboptimal investment decisions. Most jurisdictions support a national policy, and acknowledge the benefits of a national approach.¹²⁷ It is important to note that states and territories are responsible for energy policy under the Australian Constitution. The last 20 years of the NEM and the relative consistency of rules and operations over that time have not been the norm since Federation.

Table 1: Renewable Energy Targets (RETs) by jurisdiction (% of energy sourced from renewable sources)

Jurisdiction	2020 RET	2022 RET	2025 RET	2030 RET
NSW				
Vic	25%		40%	
Qld				50%
WA				50%
SA				
Tas		100%		
ACT	100%			
NT				50%
National	23.5%			

Note: The actual Federal target is 33,000 GWh from renewable sources by 2020.

Source: Clean Energy Council (2019), ACT Government (2019), Northern Territory Government (2019), Climate Change Council (2017), Department of Energy and Water Supply (2018), Victoria State Government (2017).¹²⁸

137. Challenge

Despite positive progress on the development of a national climate policy, ongoing politicisation of the issue and policy inconsistency between levels of government reduce market certainty.

Uncertainty prevents timely investment in long-term infrastructure such as electricity generation and gas pipelines, increasing risks and costs to users.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



7.4 Transitioning to Australia's future energy fuel mix

At a glance

Australia draws on a complex and changing range of fuel sources. Coal's market share is falling as wind and solar energy become cheaper and markets move towards renewable sources. Gas is also in flux, as new technologies take over its role in smoothing our supply.

Australia is undergoing an energy transformation

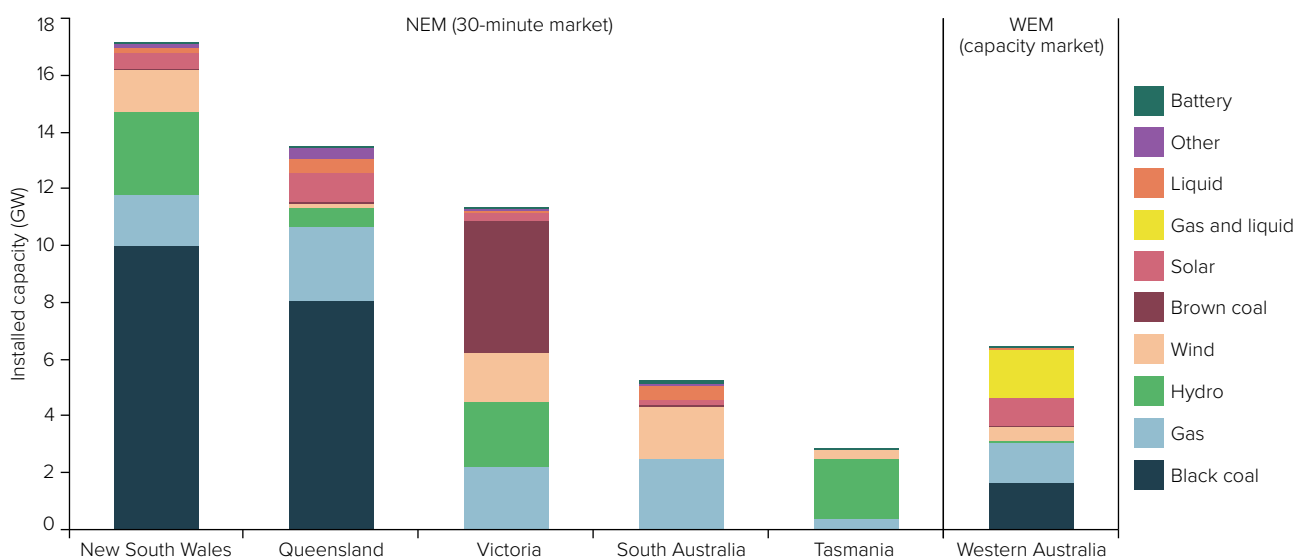
Australia's energy markets are undergoing a complex transition. Failure to adequately plan for and manage this transition could result in poorer outcomes for users, with potential repercussions for grid stability, network efficiency and higher ongoing costs for consumers.

Australia's electricity sector draws on diverse forms of generation, many of which draw from an abundance of domestic sources of energy, as shown in Figure 17. Despite this abundance and diversity – or perhaps because of it – efficiently and reliably delivering

electricity to users remains a key challenge for the sector.

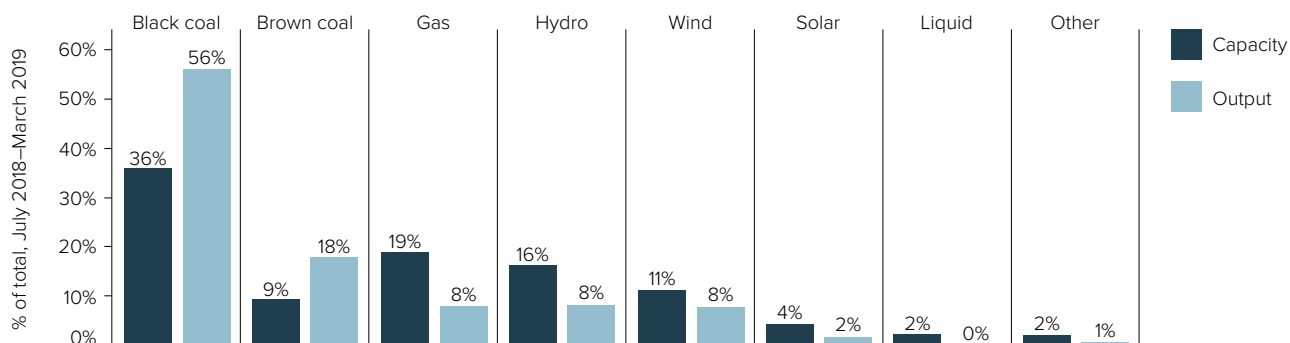
Each form of energy generation has different characteristics that determine how quickly and reliably they can be deployed. As electricity systems rely on supply always meeting or exceeding demand, it is essential to have versatile fuels that can cover unexpected events, and a level of confidence that bid volumes can be delivered at all times. Figure 18 shows installed infrastructure capacity by fuel source as a proportion of the NEM and compares each fuel against the proportion actually delivered, in the second half of 2018.

Figure 17: Fuel sources vary considerably by region in the current wholesale market



Source: Australian Energy Regulator (2019), Australian Energy Market Operator (2018)¹²⁹

Figure 18: Different fuels have different strengths, which impacts capacity and generation output



Note: Figure represents capacity and output from NEM fuel sources for July-December 2018.

Source: Australian Energy Regulator (2019)¹³⁰

Coal-fired generation is playing a diminishing role

For the last century, Australia's electricity system has relied heavily on coal-fired power as the main fuel source for electricity generation. Coal has also played a major role in regional growth. The LaTrobe Valley in Victoria, the Hunter Valley in New South Wales and Collie in Western Australia, among other regions, have for generations revolved around the local power stations and respective coal mines that fed them, with coal fired power contributing almost 80% of the nation's electricity at its peak.¹³¹ The abundant and cheap mix of fossil fuels gifted Australia a comparative advantage in terms of electricity prices for several generations.

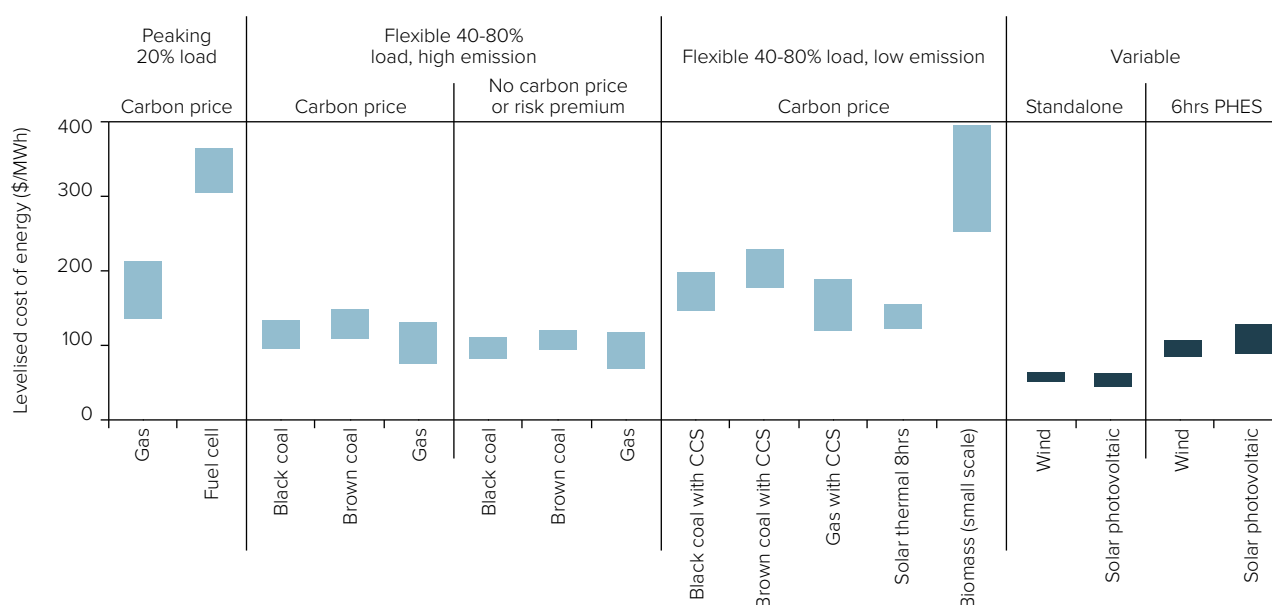
However the value of coal as an electricity input has now shifted significantly relative to other sources of supply, as illustrated by Figure 19. Over a relatively short space of time, variable wind and solar PV at large scale have come to challenge new coal plants as the cheapest sources of supply. The rapid cost reduction in renewables has coincided with factors that have magnified the severity of the change, including an increasingly peaky daily demand profile, and uncertainty as to the pricing of carbon emissions. This is due in part to a take-up by households of solar PV, which is less accommodative of relatively inflexible coal-based generation.

These developments place the NEM in the paradoxical position of being unable to commercially support new build coal-fired generation or to automatically accommodate the retirement of existing facilities. While existing market planning assumes that coal-fired generators will serve their full lives, there is a significant risk of earlier retirement occasioned by market factors. If this is not adequately coordinated, the market may not have sufficient dispatchable supply available and risks becoming increasingly reliant on expensive temporary measures, while becoming less reliable and affordable.

The NEM has already experienced several shocks triggered by one-off events, including the retirement of major coal generators. A failure to unpick the individual factors forcing the potential early withdrawal of capacity without enabling an effective replacement will leave the NEM at continued risk of supply side shocks. The Finkel Review recommendation,¹³² now a NEM rule, requiring large generators to provide at least three years' notice of closure will help to support a more orderly transition from coal generation.

Like in the NEM, the WEM has seen retirements of coal-fired capacity, and take-up of renewables. In its smaller wholesale market, concentration is high, with one vertically integrated generation wholesaler-retailer, Synergy, dominating the wholesale market. While more deregulation of the retail market is planned, the regulator is urging action to boost wholesale competition before implementing further retail deregulation.¹³³

Figure 19: Coal-fired generation is being overtaken by renewable forms of supply



Note: Levelised cost of energy by technology and category, calculated for 2020. Values are inflation adjusted to 2018–19.

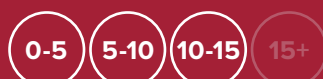
Source: Commonwealth Scientific and Industrial Research Organisation (2018)¹³⁴



138. Challenge

Many major coal generation assets are ageing and approaching retirement. The capacity they provide will need to be replaced. In the NEM, this capacity needs to be replaced or there may be impacts on reliability or competition. In the WEM, where there is overcapacity there may be scope to reduce surplus capacity. In both cases, there is a risk to the order of the market.

When this will impact:



Where this will impact:



Renewable generation has grown rapidly, and could grow much further

The costs of large-scale renewable energy generation have reduced substantially over the last decade. This has incentivised investment in renewable generation on an unprecedented scale. In 2018, one in five households had rooftop solar, and 21% of electricity over the previous 12 months came from renewable sources.¹³⁵ This figure will continue to climb off the back of \$20 billion in large-scale renewable energy projects in 2018 – twice that of the year before.¹³⁶ According to AEMO, Australia could have one of the highest ratio of decentralised non-grid generation in the world.¹³⁷ From 2050 CSIRO and Energy Networks Australia estimate that between 30 to 45% of annual electricity consumption could be supplied from consumer owned generators.¹³⁸

The ongoing cost reductions in variable renewable energy technology has made continued growth of its market share highly likely. This places Australia in an enviable position over the medium to long term given the abundant renewable resources that can be captured with relative ease. Optimally managed, Australia's renewable energy resources can form the basis of a comparative advantage similar to that provided by coal in previous decades.

Utility-scale solar generators and rooftop solar systems have near-zero operational costs. This has limited the capacity for coal and closed cycle gas generators to make revenue, creating pricing variability to which they are ill-equipped to respond.

The intermittency of renewable energy generators present a new set of challenges for electricity grids designed around large scale, stable generation facilities serving a reasonably consistent demand profile. The variable capacity of solar and wind has proved challenging for grid operators worldwide, with the need to balance load both for system frequency control and overall demand balance. A grid supplied predominantly by inflexible coal plants (that cannot be easily switched on and off) can quickly be thrown off balance by variable renewable energy with its low variable costs and intermittent (weather dependent) supply volumes. This issue has been identified in multiple reviews of the sector, with the recent Finkel Review proposing a Generator Reliability Obligation as a regulatory mechanism.¹³⁹

Renewable energy projects face varied commercial challenges. For example, generators are not be paid for energy lost in transmission from generator to end user. The total electricity lost in transmission is called the marginal loss factor. Remote wind and solar projects are particularly susceptible to higher transmission losses because generation often exceeds transmission capacity. Losses also grow over large distances and many renewable generators are located a long way from the end user. For example, the Wattle Point Wind Farm in South Australia has a marginal loss factor of 0.82 for 2018–19.¹⁴⁰ This means that this project will only receive payment for approximately 82% of electricity generated. Uncertainty regarding the treatment of these issues can impact the commercial viability of current and future renewable energy projects due to potential reductions in payment.

139. Challenge

As the penetration of small- and large-scale renewables increases across the network, additional investment in networks and generation will be required to manage reliability and service levels. This will increase capital and operational costs in networks, but will be needed to be maintain balanced supply standards.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



The role of gas in Australia's energy mix is changing

A rise in gas prices has also shifted expectations for gas' role in the future generation mix.

Following the construction of LNG terminals in Queensland that opened the east coast market to global prices, the price of wholesale gas has risen from below \$5 per gigajoule in 2009 to over \$10 across most of the east coast (Figure 20).¹⁴¹ This prompted the Australian Government to introduce a policy aimed at ensuring a sufficient supply of natural gas to meet the forecast need of energy users within Australia, by requiring the LNG projects to limit their gas exports or find new gas sources if there is a projected supply shortfall in the domestic market.¹⁴²

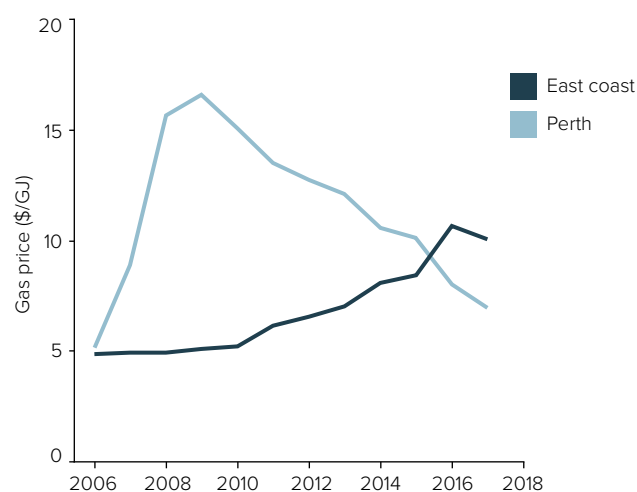
The experience is different in Western Australia, where prices have fallen over the past decade. Large exports from the west coast have been subject to a formal policy on gas reservation for domestic use for a little over a decade.¹⁴³

In the past, short-term stabilisation of the grid (known as firming or balancing) has been provided by combined-cycle gas turbine plants. Consequently, the price of gas has been frequently been responsible for setting the electricity spot price in most NEM regions.¹⁴⁴

However, the viability of combined cycle-gas turbine firming services is related to the gas price. A change in gas price will impact the competitiveness of variable renewable energy, relative to other technologies. Given the size and volume of proposed variable renewable energy generation, the grid will require a substantial expansion of complementary firming services in the coming years. In the NEM, the role of gas is likely to depend on the availability of lower cost domestic gas, possibly unlocked by opening new sources of supply.

In the Northern Territory, where gas is the main fuel source for electricity, the Utilities Commission anticipates reduced grid demand across its three regulated systems in the decade to 2026–27, driven by increased use of behind-the-meter solar PV. With the NT recently adopting a 50% renewables target, the regulator notes the technical challenges with the changing generation mix and maintaining system security.¹⁴⁵

Figure 20: Gas prices on the east coast have nearly doubled since 2010



Source: Department of the Environment and Energy (2017)¹⁴⁶



Pumped hydro and largescale batteries offer storage and firming

Wholesale generation market rules are adjusting to recognise the benefits of storage technology. In 2018, two new large scale lithium-ion battery facilities were connected to the NEM.¹⁴⁷ Large fixed batteries, such as the Hornsdale Power Reserve,¹⁴⁸ in South Australia are able to very effectively provide the rapid frequency control services that will be required to manage grid stability as the grid transforms.

The coming wave of variable renewable energy is also an opportunity for a growing role for one of Australia's older renewable energy technologies, hydroelectricity. Pumped hydro offers advantages over other storage methods, such as a longer

technical life (50 years compared to current estimates of up to 15 for most batteries), and a relatively low unit price, particularly when built at scale.¹⁴⁹

The Australian Renewable Energy Agency has identified approximately 22,000 potential pumped hydro energy storage sites around Australia with merit for investigation.¹⁵⁰ Together they have much more potential storage capacity than required across the NEM to support variable renewable energy. TasNetworks and ARENA are also proposing a second Bass Strait interconnector that would enable untapped renewable resources in Tasmania (including HydroTasmania's Battery of the Nation initiative focused on pumped hydro potential)¹⁵¹ to be used to supply and firm renewable generation in the NEM.¹⁵²

140. Opportunity

New forms of large-scale storage are increasingly available, including pumped hydroelectric and battery assets. Introduction of appropriate new firming capacity will complement variable renewable energy bids and aid the transition to the new electricity mix.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



7.5 Planning for our future energy networks

At a glance

As new fuels enter our markets, governments and regulators must plan for network growth. States have traditionally managed energy policy, but national bodies have taken over many functions. The recent Finkel Review found a rising need for whole-of-system planning and shared renewable energy zones as our interstate networks grow.

Renewable energy requires new stability services, and we must also manage our domestic gas through fragmented governance and market changes.

Networks need to keep pace with the energy transformation

Our transmission and distribution networks in the NEM, Western Australia and the Northern Territory are valuable national assets that will continue to form the core of our electricity system over the coming decades. However, significant factors are driving a reshaping of how our electricity networks will operate over the next decade.

The changing fuel mix in our electricity generation is redefining many existing start and end points of our regulated networks. To manage affordability, we need to make smart investment decisions as these networks are regulated natural monopolies whose costs are automatically added to user bills. We also need to recognise that modernisation of the grid is necessary to manage an increasingly complex energy system.

For network operators, integrating distributed energy resources at scale presents a number of technical challenges. These challenges rise considerably when variable renewable energy penetrates further into the overall market.¹⁵³

As well as the basic need to augment transmission capacity in new areas, grid operators must also manage less predictable supply, with more smaller, distributed facilities, each of which are much more weather dependent than in the past. When combined with the overall intermittency of weather dependent energy sources, the grid will also require much greater use of frequency control services to ensure continued grid stability.

While the market for such services is not new, the demand for them will continue to increase as the penetration of variable renewable energy sources grows over time. Ultimately, where previously the grid was managed in a single direction, with stable supply and relatively consistent demand, the future electricity grid will likely require tighter management, as well as timely planning coupled with efficient investment to ensure that users' desired reliability of supply is maintained.

Operators are planning for future network needs

A key recommendation of the Finkel Review was for the development of what is now called the Integrated System Plan (ISP) for the NEM, which was released by AEMO in July 2018.¹⁵⁴ This plan seeks identify the most efficient means of meeting supply across the NEM as a whole, and forecasting the transmission investments needed to support it. The ISP identifies three distinct stages of transmission investment areas of focus:

1. Pre-2020: Transmission bottleneck upgrades
2. 2020–2030: Connecting strategic storage initiatives
3. 2030–2040: Increased interstate capacity and intrastate connection of Renewable Energy Zones

The first stage of the ISP is being expedited to increase connections between regions and strengthen parts of the southern regions. Importantly, notwithstanding reference their inclusion in the ISP, individual transmission investments projects are still expected to produce positive business investment cases under the Regulatory Investment Test before approval.

The 2019 Infrastructure Australia *Infrastructure Priority List* includes the AEMO ISP Stage 1 projects as a Priority Initiative over the next five years, and the latter two stages as a High Priority Initiative over the 5–15 year horizon.¹⁵⁵

Steps to implement the ISP through coordination of generation and transmission investment (COGATI) decisions in the interests of consumers are also being taken, at the request of COAG Energy Ministers.¹⁵⁶ There are currently many competing generator (generally renewable energy) proposals to connect to networks. However, not all will proceed, and users have an interest in least cost transmission upgrades during the market transition.

In the South-West Interconnected System in Western Australia, Western Power has taken steps to minimise the costs of network augmentation during the shift in generation mix towards renewables. This includes the option of market reform to open up access for new generation to existing networks via ending the existing unconstrained access of the large established generators. In turn, this will enable a lowest-price dispatch system for generation on the existing network, and encourage competition, similar to the NEM.¹⁵⁷

Managing network planning for the NWIS in the Pilbara region is much harder, given the winding up and down of major energy-using projects, and their workforces, across the export commodity cycle. This makes long-term planning for regional power needs very difficult, and developing solutions is often part of the project approval process.

141. Challenge

Transmission networks need to respond to new generation in areas not currently served or without sufficient spare capacity. The outcome of these decisions will be paid for by users over many years. It is in the interests of users that the transition is efficient and guided by well-targeted investment.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Renewable Energy Zones can help to direct efficient investment

A part of the ISP is to identify which parts of the NEM can best accommodate the coming wave of renewable energy investments that is forecast over the medium term. These are mainly large-scale wind and solar generation.

Retiring coal plants will need to be replaced, and the least cost means of doing so is likely to be a combination of renewable energy and firming services (via storage to address variability). Geographically however, these new fuel sources are unlikely to be located in the same place as the existing coal plants, and a reconfiguration of the transmission network will be required in order to accommodate the new renewables expected to be built by 2040.

Amid competing proposals, the ISP seeks to identify those locations where renewable resources overlap with existing parts of the transmission network with additional capacity and which have high quality renewable resources which provide diversity and can be integrated into the grid without causing material technical issues.

Renewable Energy Zones (REZs) are being prioritised for investment and to connect them to the grid. These zones will also require state planning approvals, and either economic assessment of regulatory funding by the AER, or coordination of commercial funding to support development. A feature of proposed REZs is the shared nature of transmission infrastructure, which means that coordinated connection of generators to the same transmission line can reduce the overall scale of new network investment and result in lower costs, compared with each generator connecting individually.

142. Opportunity

Coordinating investment in new generation and network assets in Renewable Energy Zones can promote investment in renewable generation, provide clarity for network investors, and increase scale and lower costs for new generation providers. Optimising investment in Renewable Energy Zones will lead to lower wholesale and network costs for users over time.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Gas infrastructure is adapting to changes in the market

How domestic gas is transported to distribution networks and industrial users matters. Australia's gas transmission pipeline network is fragmented into three networks – eastern, northern and western, with the recent construction of the Northern Gas Pipeline connecting the Northern Territory's gas production to the east coast grid (Figure 21). The network is now privately run, though regulated to varying degrees.¹⁵⁸

New or expanded sources of supply are likely to result in a need for new pipelines and processing facilities. Some potential sources are in remote on-

and offshore locations, such as the Beetaloo Basin in the Northern Territory, and may require substantial investment to connect them to domestic markets and export facilities.

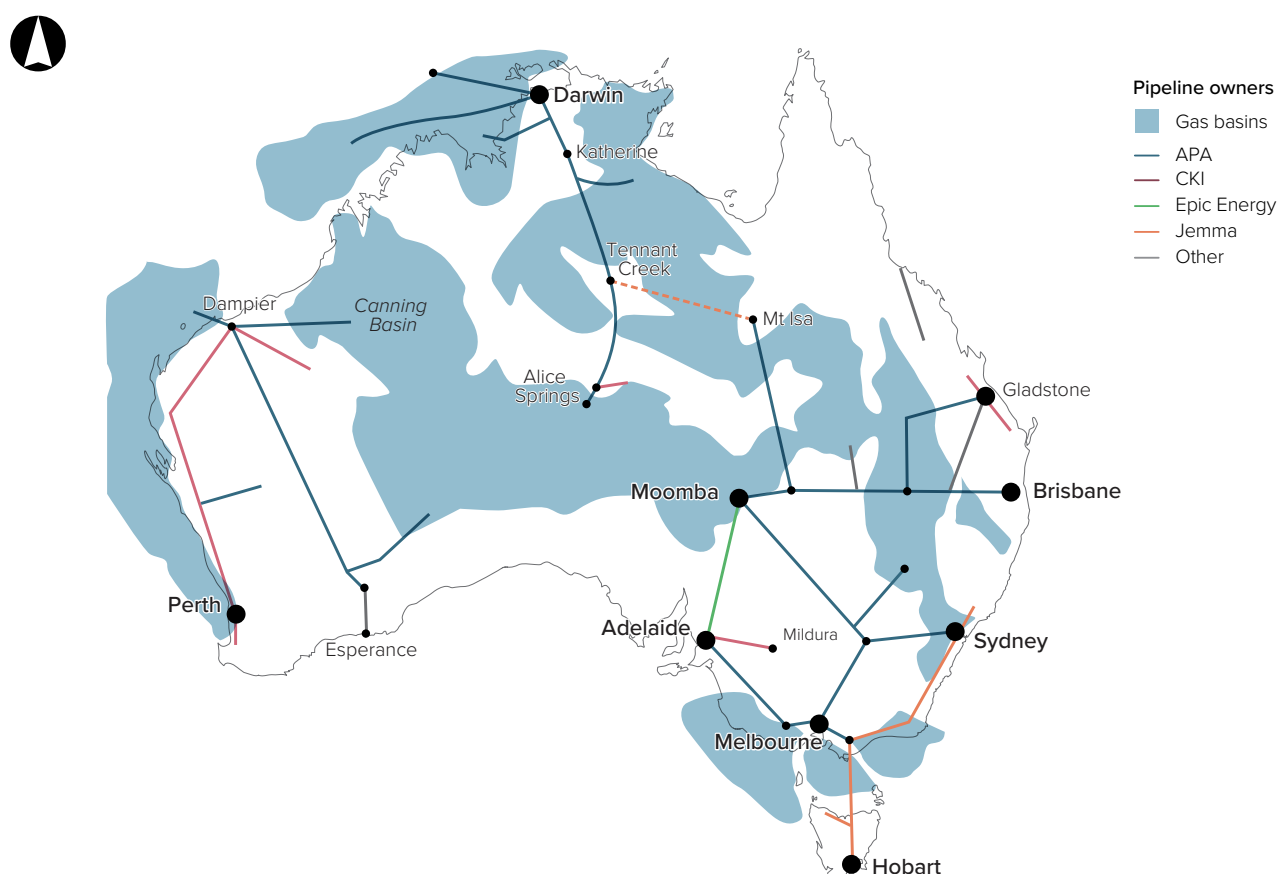
Recently legislated reforms as part of the *East Coast Wholesale Gas Market and Pipeline Frameworks Review* will see a number of steps taken to optimise the use of these pipelines to ensure that gas is delivered at the lowest cost wherever possible.¹⁵⁹ Reforms include mandatory trading of unused pipeline capacity (known as secondary trading), improved information provision for all stakeholders, and concentration of trading activity at two main gas hubs.

The Northern Gas Pipeline

The Northern Gas Pipeline was commissioned by the Northern Territory Government and received permitting and approval support from the Queensland and Australian Governments. The Northern Territory Government initiated a competitive bidding process in 2014 with the aim of increasing access to Northern Territory gas markets. The project was awarded to Jemena in November 2015 and was entirely privately funded to the value of around \$800 million.

First gas flowed in December 2018. The project consists of 622 km of buried 12-inch gas pipeline and involved 10 Indigenous Land Use Agreements. The Northern Gas Pipeline connects the existing Amadeus and Carpentaria gas pipelines. Should further connections eastwards to the Galilee Basin in Queensland be built as is currently being planned, the Northern Gas Pipeline will enable gas from the centre of Australia for the first time to be delivered to Gladstone and increase supply to manufacturers in southern markets.

Figure 21: Australia's gas transmission has three main networks – eastern, northern and western



Source: Sydney Morning Herald (2018)¹⁶⁰

7.6 New opportunities for consumer choice

At a glance

This section looks at how technology has allowed users to take control of their energy supply. Private energy production can improve our grids, but poor planning raises user costs. Small-scale solar is becoming increasingly affordable, however, different regional governance arrangements are affecting take-up.

We face challenges in integrating small private assets into our grids, making solar energy accessible to lower income households, and improving consumer control and visibility over their energy use.

But we have an opportunity to use electric vehicles for short-term electricity storage.

Many consumers and businesses are taking control of their energy

In 2008, Australian grid consumers owned almost no small scale energy assets. Over the last decade, two million premises (about 20% of the total) have installed rooftop solar systems. Rooftop installed capacity has grown to over 6,000 megawatts, and if larger systems are included, there are now over 10,000 megawatts installed nationally.¹⁶¹

New assets have transformed some traditional consumers into energy producers, otherwise known as prosumers.¹⁶² From an historical perspective, if energy generation increases in close proximity to where it is consumed, this invites comparison with a century ago, before our centralised networks were formed, to when fire, oil and gas were used in the home for energy.

Many modern users want more affordable and environmentally responsible energy options. Private assets allow these consumers to reduce their bills, avoid some of the uncertainty of grid costs and acquire a sense of control over their energy use. A 2018 survey indicated that 60% of respondents installed solar PV systems because they want to reduce their reliance on grid electricity.¹⁶³

Consumer assets also need to be integrated into grids. Neither legacy infrastructure nor electricity market regulatory frameworks were designed with rooftop generation in mind. Our electricity system was designed for electricity to flow in one direction: from large generators to consumers. A local distribution network can only host a proportion of bi-directional electricity flows before new expenditure is needed to stabilise the system and keep it within operational parameters.

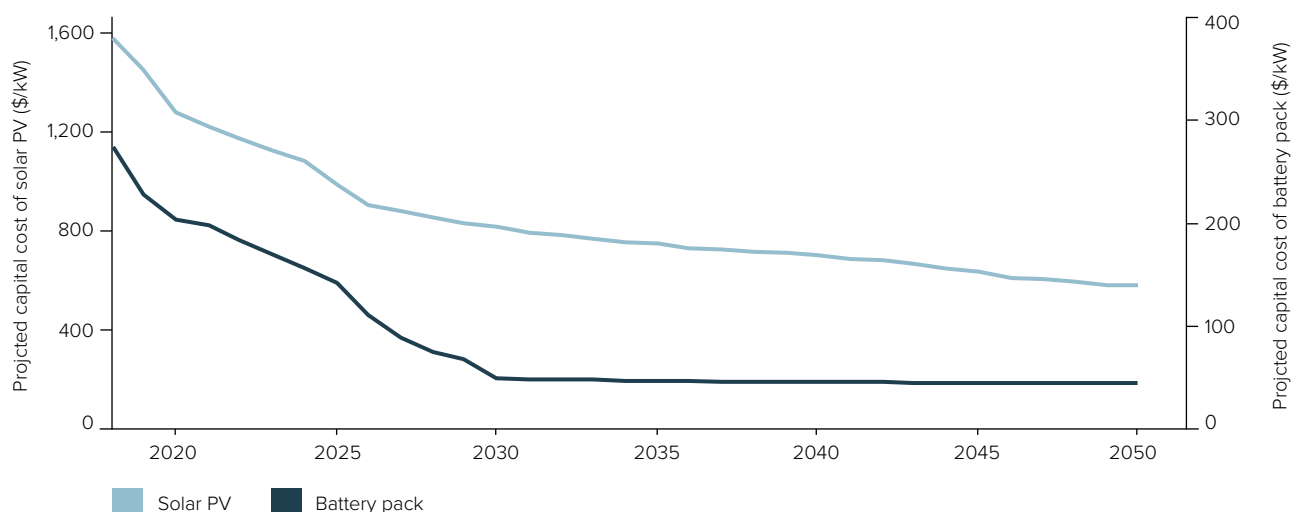
The cost of solar panels and batteries is falling

Australia now has one of the highest rates of adoption of household rooftop solar systems in the world. Batteries, smart appliances and electric vehicles, which sit behind the meter (outside the central grid), are mostly newer and have been adopted in smaller numbers. Uptake is likely to continue to grow, as CSIRO forecasts indicate continued falls in the cost of solar panels and battery storage technology.

Over the next 10 years, many more consumers will likely adopt home battery storage. Battery prices have fallen by 80% over 2010–17,¹⁶⁴ and are expected to continue to drop until 2030 (Figure 22). As with solar panels initially, the incentive to buy a battery will also be influenced by estimates of payback periods. Batteries could increase system paybacks because they could store cheap electricity during the day and use it at night when the grid price is higher. This type of tariff reform has often been mooted but is yet to be regulated in Australia.

Due to its current high price, battery storage presently only provides niche services to residential consumers. Only 2.6% of consumer solar systems installed currently partner with a battery system.¹⁶⁵ This is not due to a lack of interest in the technology. A 2018 survey found that between 24% and 39% of consumers across Australia's energy markets were considering purchasing a battery storage system.¹⁶⁶

If high take-up occurs, AEMO predicts that Australia could have the most decentralised energy market in the world.¹⁶⁷ By 2050, CSIRO and Energy Networks Australia estimate that between 30 to 45% of annual electricity consumption could be supplied from consumer owned generators.¹⁶⁸ This has significant implications for all users, and for electricity infrastructure, as increasing decentralised resources lead to two-way flows on the networks and fundamentally changes the shape of demand for grid-based electricity.

Figure 22: The projected capital costs of solar PV and batteries are forecast to continue to decline

Source: Commonwealth Scientific and Industrial Research Organisation (2018)¹⁶⁹

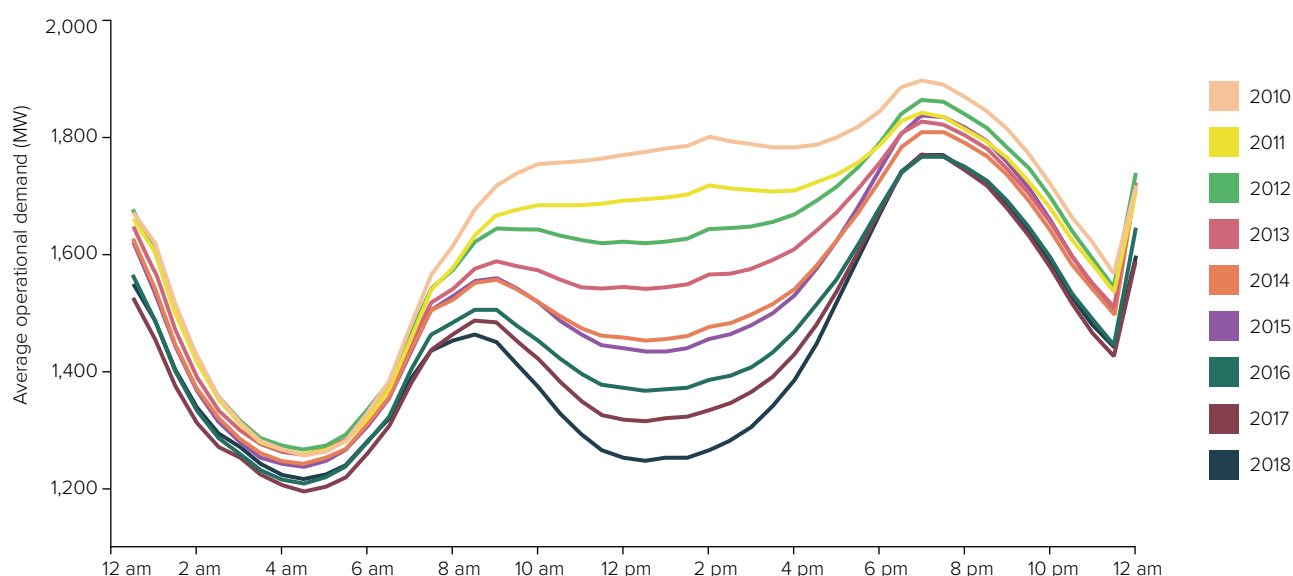
Small scale assets are changing patterns of demand for grid electricity

Small scale assets, and in particular solar PV, are significantly altering the profile of demand for grid supplied energy. Less grid power is being used when the sun is shining during the day, but a large amount of grid power is still required at peak times, when solar is not available. The effect of large scale solar PV adoption by consumers and industry on demand is shown in Figure 23.

Daily peak demand typically occurs between 5pm and 8pm. This increase in demand can be attributed to people returning from work and using energy intensive appliances such as air conditioners, cooking

appliances, televisions and, in time, electric vehicles. Electricity must be generated and distributed to meet these needs.

New patterns of demand are likely to pose an operational challenge for market operators. Low periods of demand for grid electricity make it difficult to maintain minimum levels of generation to respond to large increases in demand. If incorrectly managed this can impact grid stability. New generation assets, such as pumped hydro or battery storage, can help smooth the effects of solar and wind intermittency, and increase grid reliability.¹⁷⁰ These assets can also provide capacity and ancillary services, which help manage new patterns of grid demand.

Figure 23: Solar PV adoption is having large impacts on grid demand in Western Australia

Source: Australian Energy Market Operator (2018)¹⁷¹

Adapting to and benefiting from energy storage assets

Battery storage has potential to delay or negate the need for network investment and help smooth the intermittent nature of renewable generation.¹⁷² Large fixed batteries such as the Hornsdale Power Reserve in South Australia provide rapid frequency control services that improve grid stability and reduce energy bills.¹⁷³

As the price of battery storage and energy storage declines, these assets could become more widespread across the grid and in users' homes. Large scale investment, helped by incentives, is already occurring. In September 2018, there were 55 large-scale energy storage projects that were existing, under construction, planned or proposed.¹⁷⁴

Regulation will play a large role in how consumers adopt storage behind the meter, and investment in larger scale utility storage in the wholesale market.¹⁷⁵ It will be a challenge to ensure that regulatory frameworks are flexible and transparent enough to encourage private and consumer investment in energy storage.¹⁷⁶

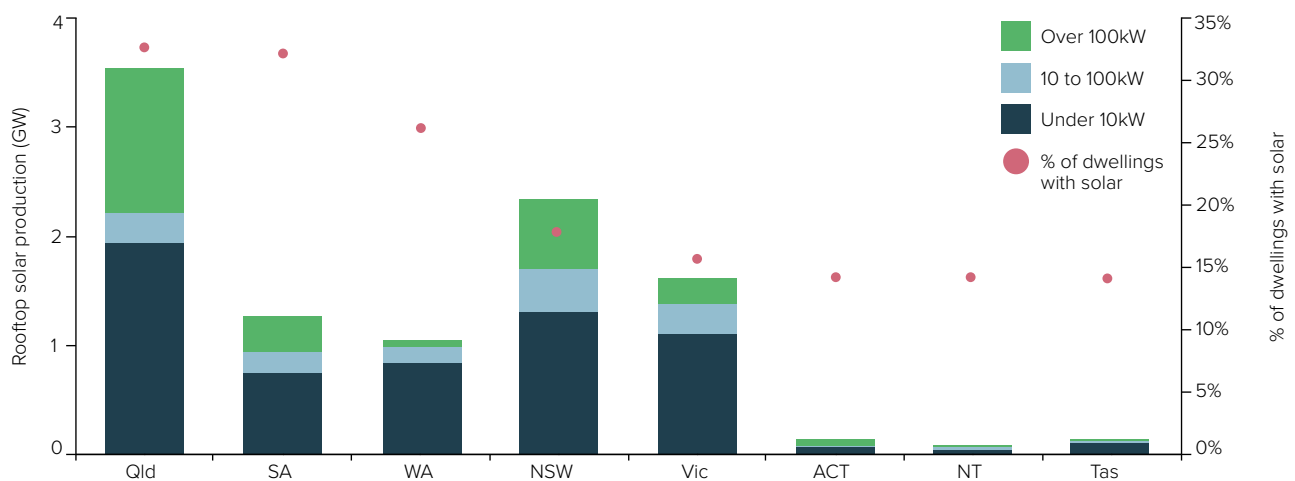
Rooftop and small-scale solar take-up varies across regions

Rooftop and small industrial installation data shows that different states and territories have different solar take-up rates (Figure 24).

This is in part because different regions have slightly different solar capacity factors (around 21% of nameplate capacity for fixed panels)¹⁷⁷ – meaning that some places are sunnier than others, and therefore able to generate more power per solar panel over a period of time. Capacity factors reflect a ratio between technical full capacity (that is energy generated if the sun shone 24 hours a day, and actual generation levels).

Generally capacity factors are higher in Australia's northern regions. This is in part why Queensland leads on both large and small rooftop capacity installed, and proportion of overall premises with solar installed. It is notable that the Northern Territory currently lags on proportion of premises with solar installed.¹⁷⁸

Figure 24: Rooftop solar take-up varies across jurisdictions



Source: Australian Photovoltaic Institute (2018)¹⁷⁹

User uptake is affected by uncoordinated government policy

Renewable energy targets, government subsidies and high feed-in tariff schemes have also incentivised take-up of rooftop solar systems. These include federal policies, such as the Small-scale Renewable Energy Scheme,¹⁸⁰ and other state and territory policies. These impact take-up and reshape grid infrastructure, but are largely unconnected, despite most of these jurisdictions being part of a competitive national market.

Figure 25 illustrates the rapid growth in small scale solar take-up for the four largest states, and also charts the smaller jurisdictions. It shows different rates of growth – for instance, New South Wales led

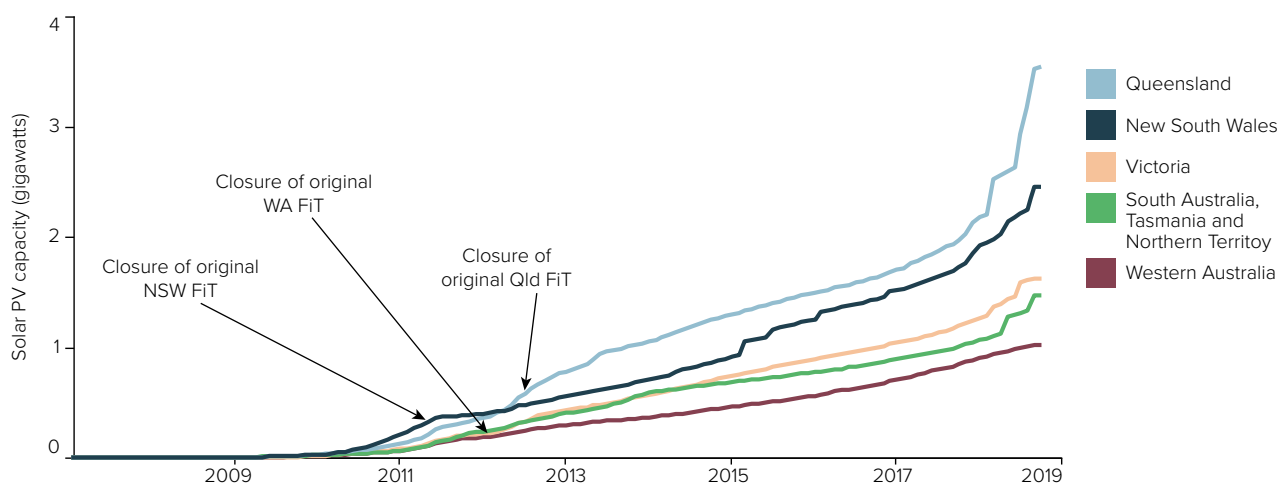
take-up in the early part of the decade, and was then surpassed by the less populated Queensland, with their original, generous feed-in-tariff (FiT) schemes finishing at different times. The original Western Australian FiT scheme closed in August 2011.¹⁸¹

Solar FiT schemes in various jurisdictions provide varying levels of incentives for investment. Retailers offer to buy rooftop solar electricity at a certain price. To the extent that these tariffs are higher than the market price for generation, there is an incentive to invest. Initially, these schemes offered generous tariffs for all energy generated, but most have closed, been restructured or wound back towards the market price, or voluntary operation. However mandatory schemes with retailer obligations remain in the ACT, Victoria and South Australia.¹⁸²

The kinks in the growth paths for each jurisdiction can be linked to policy changes at the state level (and some at the federal level with general application), which either increased or reduced incentives. In the background, capital costs were declining across the whole period. It underscores that user take-up is impacted by calculations of payback periods, after accounting for a range of factors, including capital cost, government subsidies, and FiT schemes.

While there are a range of drivers for these policies, and they differ across jurisdictions, achieving a reduction in grid prices would lengthen rooftop solar payback periods. This could in turn reduce demand for rooftop solar below what it would otherwise be. With several governments directly subsidising behind-the-meter solar, it appears that government energy policy levers are working against each other.

Figure 25: Government policy has influenced solar PV adoption over the past decade



Source: Australian Photovoltaic Institute (2018)¹⁸³

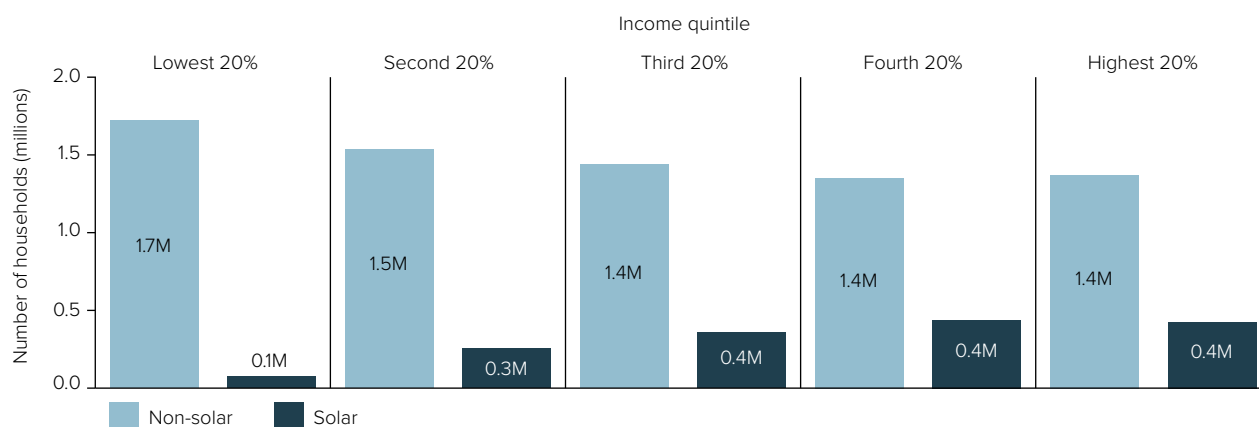
Take-up has tended to be in middle to higher income groups

As more solar and storage is adopted, households without access to private assets could pay more of overall grid costs. Network costs are typically recovered through units of grid energy sold under current tariff structures. Perversely, the most vulnerable people, who are generally less able to reduce their reliance on the grid, have the least flexibility and choice. However, network tariff reform is continuing across all jurisdictions, with many networks introducing demand charges to better

capture the key drivers of network costs and provide signals for customers to change their demand in ways that reduce the need for future investment.

Research for the Australian Council of Social Service suggests that higher and middle-income households are more likely to install rooftop solar PV, as shown in Figure 26.¹⁸⁴ These households have both an incentive to reduce bills, and the means to afford the residual out-of-pocket capital cost. Low-income users, sole parents and public housing tenants are less able to afford solar PV installation, yet shoulder a higher electricity burden as a proportion of income.

Figure 26: More higher and middle income households have accessed rooftop solar PV than lower income households



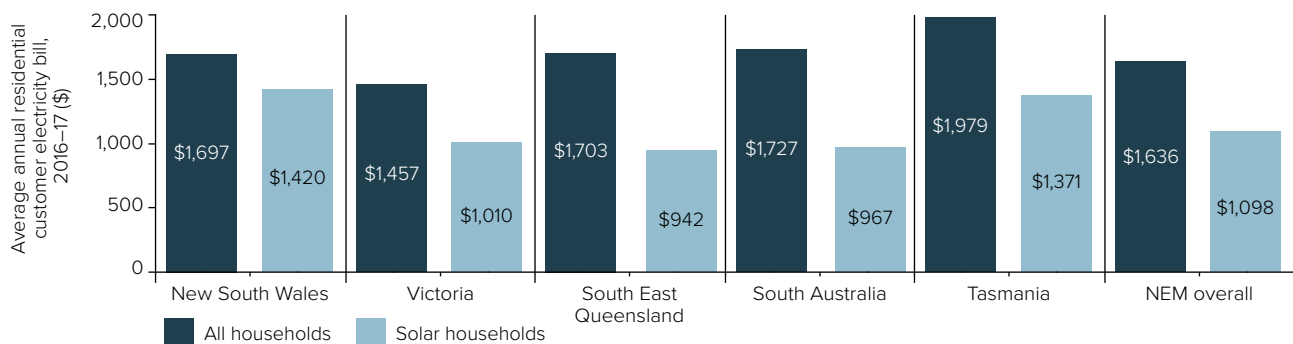
Source: Australian Council of Social Service (2018)¹⁸⁵

Landlords and renters are in a split incentive position where the landlord's incentive to make an upfront capital investment is weak due to the benefit accruing to the tenant via lower bills. This is a significant issue as 31% of households are rented.¹⁸⁶ In Victoria, community housing providers can apply for solar panel rebates on behalf of their tenants.¹⁸⁷ There has been innovation around cost support for landlords' financing, with benefits shared through a small rent increase. Some councils in Melbourne and Adelaide have offered financing benefits to landlords via rates instalments.¹⁸⁸

Figure 27 shows the average annual residential customer electricity bill for each NEM region, and the average annual bill for a solar customer in the same region. The gap at the top is the notional subsidy paid by retailers from revenues collected from all customers. In effect, these are paid for by non-solar customers via their bills (except in Queensland where it is now funded directly by taxpayers).¹⁸⁹ Note that electricity bill totals are impacted by differences in gas usage across jurisdictions.

The annual gap between lower average solar and higher average non-solar NEM customer bills in 2016-17 was calculated by the ACCC as 33%. That averages at \$538 per customer.¹⁹⁰

Figure 27: Solar customers on average pay far less than non-solar customers across the NEM



Source: Australian Competition and Consumer Commission (2018)¹⁹¹

143. Challenge

Home solar and storage can help users to save costs and control energy use, but government policies are uncoordinated. Developments in behind the meter energy systems risk leaving some users behind, while uncoordinated policies and subsidies add to costs over the long term.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



Shifting time of use can save expensive new peak capacity

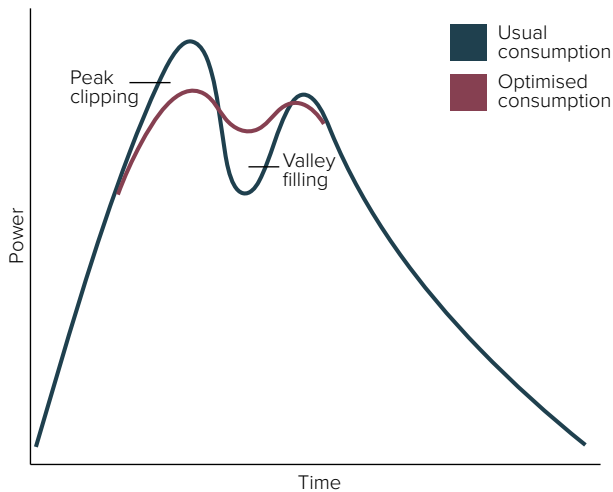
Demand response occurs when consumers act to reduce or shift demand for electricity across the day at times of tight supply. It acts as an alternative to providing new capacity to meet rare and rising demand peaks. Figure 28 shows a simple example of demand peak shifting. Consumers are paid to reduce or defer their electricity use, lowering peak power demand in the system, and deferring new investment. Even the very occasional use of demand response can have a significant impact on lowering consumer bills.

In Australia, demand response management programs are beginning to take shape. Only around 235 MW of demand response is available to contract

retailers, despite there being over 2,000MW of load that consumers would be willing to reduce for cost savings.¹⁹² 64% of consumers say they are willing to reduce their energy usage at times of very hot weather, yet very few do.¹⁹³

Retailers such as Mojo Power, Powershop, United Energy and Energex have trialled demand response programs during peak demand periods.¹⁹⁴ Ergon Energy's demand response program allows the retailer to remotely activate economy mode for participating consumers' air conditioners for short periods of times when the electricity network nears or reaches peak demand. Air conditioner use is only reduced for a few days of the year.

Figure 28: Consumers can shift their demand across the day to optimise consumption and save costs



Source: Northwest Power and Conservation Council (2019)¹⁹⁵

In addition, we are starting to see the development of platforms that allow the aggregation of household energy resources that can then be offered to the grid as an alternative tool to manage peak demand on the network, as well as facilitating the sharing of resources between households ('peer-to-peer trading').

Despite the growing array of consumer energy assets, most Australians have limited control over their energy use. This is partly because only a small proportion of consumers have access to a smart meter. Consumers with smart meters can more effectively manage their bills.

Most Victorians, where a government led rollout has occurred, have smart meter access. However, outside of Victoria, only 5% of consumers have a smart meter.¹⁹⁶ Australia is lagging behind other nations. The European Union plans to install up to 80% smart meters by 2020, where it is cost effective to do so.¹⁹⁷ Delay in the Australian rollout has been caused by poor coordination between network businesses, retailers and metering coordinators, inadequate resourcing, a backlog of jobs and poor retailer systems.¹⁹⁸

Even without smart meters, there remain options for consumers to gain greater control of their energy use through the adoption of smart appliances, and through tariff reform that provides stronger signals to consumers regarding the costs they impose on the network.

Managing pool pumps

The Australian Renewable Energy Agency (ARENA) has funded technology that optimises and automates energy use for swimming pool pumps. Typically 40% of swimming pool owners' household energy use is related to their pool.¹⁹⁹

The trial aims to provide a low cost, low impact option to curb consumption during peak periods to prevent outages and reduce bills. While one or two pool pumps are insignificant, coordinating the over 1.2 million swimming pools in Australia could provide significant energy savings.

144. Opportunity

Demand response from users can defer or avoid expensive new electricity infrastructure investment, and better use existing infrastructure. This can save users the passed on costs of higher peaks.

When this will impact:



Where this will impact:





Plug-in electric vehicle batteries could store and export electricity

Electric vehicles (EVs) could allow users to have an additional layer of control and choice over their energy. Over a five to ten year timeframe, EV batteries could also play a secondary role as a short-term storage of electricity. This will, however, require addressing some cost and technical issues.

EVs, which on average sit idle for 95% of the time,²⁰⁰ could take advantage of cheap, off-peak energy to charge up. Their mobility also allows them to act as a literal battery on wheels, sourcing power at one time and using or dispatching it at other times. When electricity is used locally and not transported large distances, there is less demand for expensive network infrastructure.

EV batteries could be an energy asset of national significance. By 2040, Bloomberg New Energy Finance predicts that 40% of Australia's vehicle fleet could be electric and act as a reservoir of storage. The potential is similar to the capacity of the proposed Snowy 2.0 scheme.²⁰¹

Several regulatory and technical barriers exist before EV-to-grid can have application in Australia. To export electricity, consumers require a costly residential bi-directional charger and a smart inverter.

And, with existing technology, exporting electricity accelerates the degradation in capacity of EV batteries.

More fundamentally, Australian consumers have been slow to embrace EVs, amidst concerns about their cost, driving range and access to charging stations.

145. Opportunity

Electric vehicles could provide additional storage capacity to stationary electricity systems. There are regulatory and technical barriers to be overcome. This may provide a means of converging stationary and non-stationary energy at household level.

When this will impact:



Where this will impact:



7.7 Delivering energy in remote communities

At a glance

Remote and regional communities have reasonable access to electricity, but cost and reliability are major issues. Micro-grids have inconsistent regulation and often rely on costly imported diesel.

Renewable energy solutions could greatly improve this. Many local industries are already adopting these, but increasingly non-standard infrastructure poses challenges for regulators.

Rural and remote energy users and service providers face higher costs

The vast majority of Australian households and industry have access to energy in the form of electricity. Australia has a highly dispersed population spread across challenging geographic terrain. We also have a number of island regions and external territories. Electricity supply in these more remote areas is provided either via the main grid, or through stand-alone power systems. In both cases, electricity supply in these more remote areas is typically characterised by a higher cost of supply and lower levels of reliability. As shown in Figure 29, the key driver of cost is customer density.

Some Community Service Obligations (CSOs) have been funded directly from government budgets. In Queensland, for example, the government paid \$465 million to Ergon Energy Retail in 2018–19 to ensure regional and remote customers paid similar electricity prices to other users.²⁰² As a consequence, many users in regional and remote areas are insulated from paying the true cost of supply.

Remote users face distinct reliability challenges

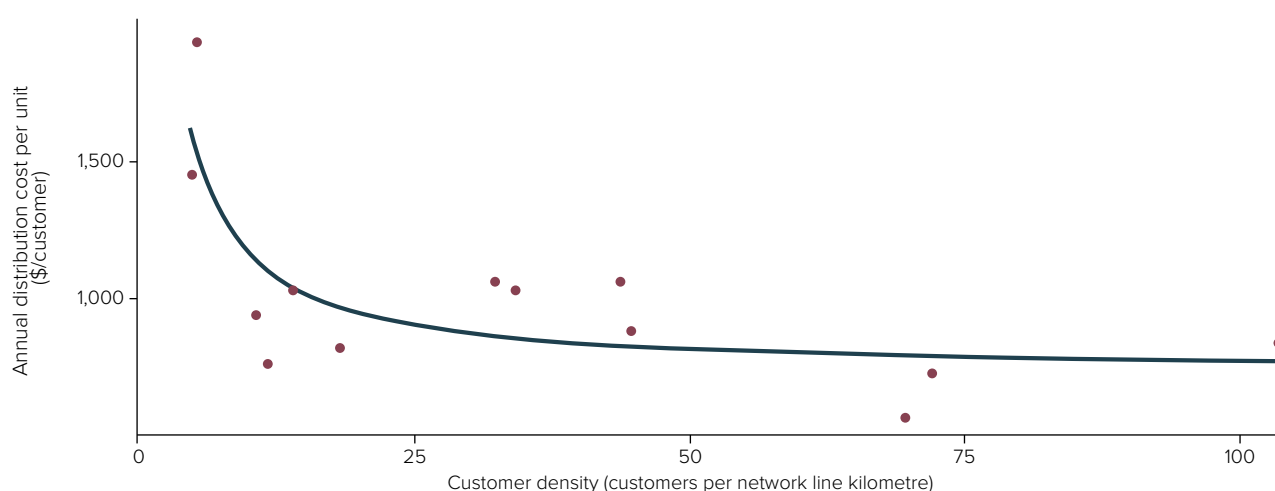
The trade-off between cost and reliability is a particular issue in low population density areas.

The AER's Service Target Performance Incentive Scheme operates by measuring average outcomes across major sections of the network. In a review of reliability standards, the Essential Services Commission of South Australia (ESCOSA) found that this can produce a decline in reliability in lower density areas.²⁰³ The AER has acknowledged its scheme may distort outcomes by over-incentivising distribution network businesses to improve supply where it is not valued by consumers.²⁰⁴

ESCOSA has proposed changes to its reliability regime and Guaranteed Service Level scheme. Guaranteed Service Level payments will no longer be made to customers who typically have average or good reliability, but experience a one-off outage (of less than 20 hours). Queensland is also considering whether Guaranteed Service Level payments should be directed toward 'worst-served individual customers'.²⁰⁵

End-of-grid decision-making involves substantial choices about the costs and benefits of connecting (or remaining connected) to the centralised grid, as technology creates new options with separate costs and benefits. The Australian Energy Market Commission (AEMC) is seeking to determine a fit-for-purpose regulatory regime that would apply to communities or individuals wishing to leave the grid and establish a new micro-grid.²⁰⁶

Figure 29: Electricity distribution costs are higher for smaller communities



Source: Australian Energy Market Commission (2018)²⁰⁷

Many remote systems rely on diesel and LPG

Electricity is supplied to regional and remote communities at the edge of grid using centralised power and embedded networks. In areas where electricity is provided off-grid via a stand-alone power system, services can be delivered through either a micro-grid, involving several customers and with a mix of generation and storage assets, or an individual power system. Information on stand-alone power system locations, generational sources, locations and costs is very limited.

Many areas rely heavily on diesel and LPG generators, with fuels typically delivered by trucks. The use of diesel-based electricity generation can have negative effects on remote communities. As it is required to be transported, it has potentially high supply costs and can require increased road maintenance.

Kaltukatjara in the Northern Territory, which is home to around 3,000 people, requires 60,000 litres of diesel fuel to be transported every eight weeks over a distance of more than 2,000 kilometres.²⁰⁸ Washed out or flooded roads can delay delivery and compromise energy security. Remote communities and businesses operating diesel generators can also face uncertain petroleum prices.²⁰⁹ Diesel generators can also have environmental impacts due to noise, emissions and spillage.

The growth and development of communities can be constrained by the capacity of their power generator. Where new capacity is needed, and a major capital expenditure decision is required, this can leave growth aspirations unmet.

Remote micro-grids are growing across Australia

Micro-grids can involve both generation and distribution infrastructure. They can range in size and ownership from the Mt Isa-Cloncurry micro-grid, which serves over 10,000 users, to the Mt Stirling micro-grid used to service a private ski resort in Victoria.

As shown by Figure 30, Ergon Energy owns and operates 33 remote micro-grids throughout Western Queensland, the Gulf of Carpentaria, Cape York, some of the Torres Strait Islands and Palm and Mornington Islands.

In South Australia, the Remote Areas Energy Supply scheme supplies electricity over an area of approximately 210,000 square kilometres, as shown by Figure 31. Services are provided to around 2,400 customers in 13 remote towns via micro-grids, and approximately 1,000 further customers through the Aboriginal Communities scheme.²¹⁰

146. Challenge

The costs of serving remote and regional areas remain high, with customers in those areas also often receiving poor reliability outcomes. Poor energy reliability in remote areas undermines quality of life and opportunities for growth and investment.

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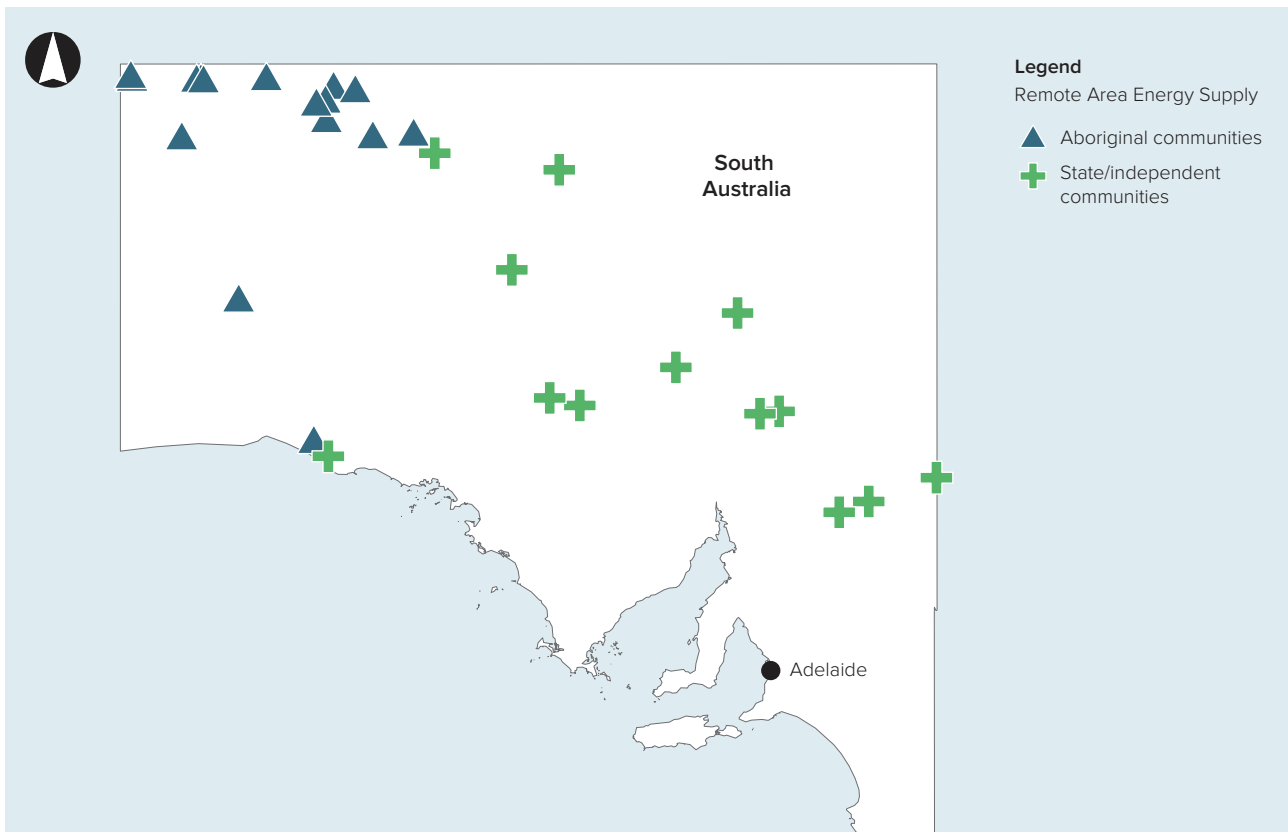
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Where this will impact:



Figure 30: Ergon Energy operates 33 micro grids in QueenslandSource: Ergon Energy (2019)²¹¹**Figure 31: Services are provided across South Australia through the Remote Areas Energy Scheme**Source: Department for Energy and Mining, Government of South Australia (2019)²¹²

The Northern Territory Government, through Indigenous Essential Services – a subsidiary of Power Water Corporation – provides more electricity to 72 remote towns and communities, as shown in Figure 32. This network includes 52 diesel-fired

and renewable power stations and nearly 1,400 kilometres of power distribution lines.²¹³ Reliance on diesel is expected to decline over the next five years as more renewable energy, storage and low emissions options become cost-effective.²¹⁴

Figure 32: Remote communities serviced by Indigenous Essential Services

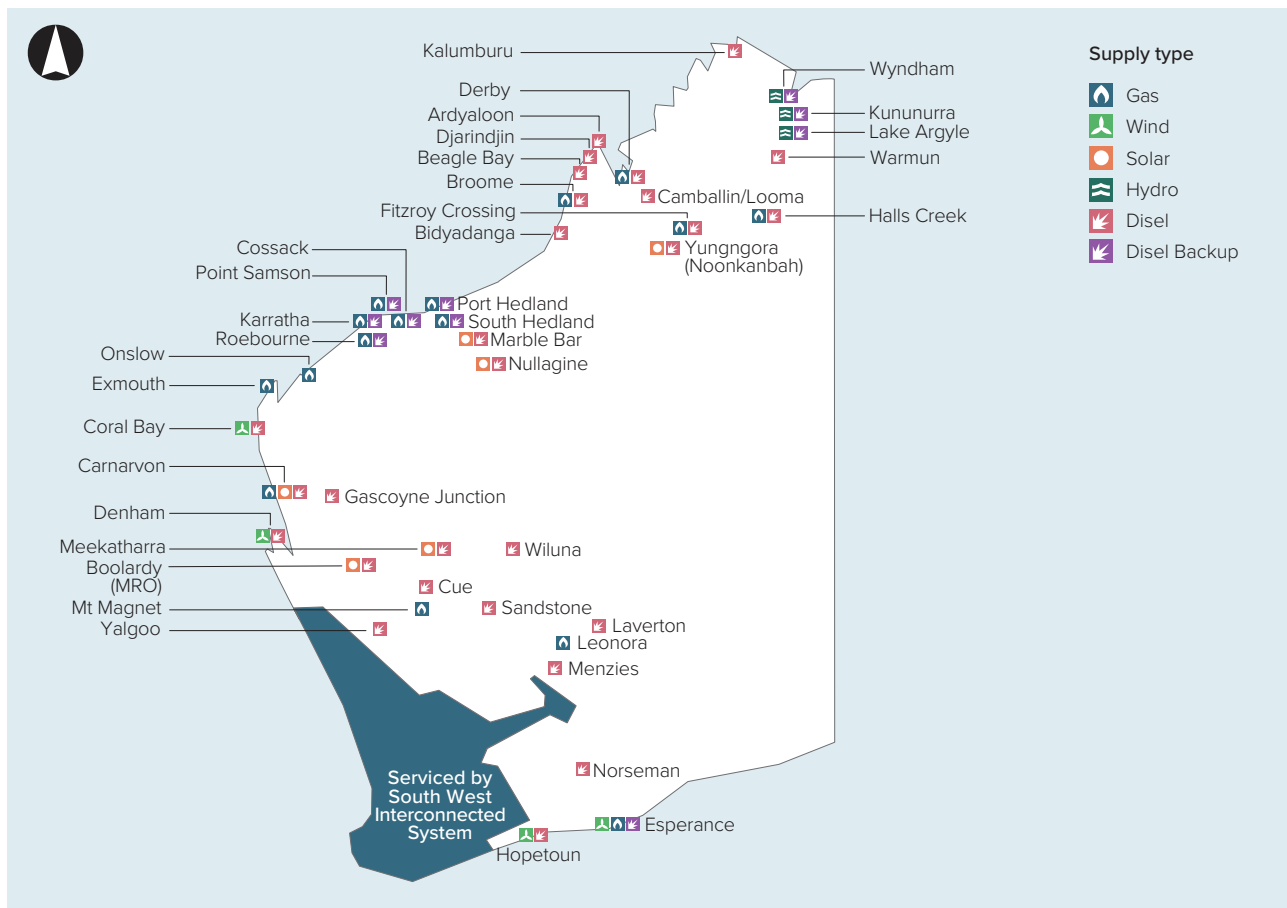


Source: Power and Water Corporation (2013)²¹⁵

The Western Australian Government provides services through Horizon Power to more than 100,000 people and 10,000 businesses at 47,000 connections across 2.3 million square kilometres.²¹⁶ Horizon Power's network includes 37 micro-grids and

eight micro power systems (Figure 33).²¹⁷ A further 91 Aboriginal remote communities are served by around 200 micro-grids, funded under the Remote Essential and Municipal Services program and run by the Western Australian Department of Communities.²¹⁸

Figure 33: Horizon Power provides service throughout Western Australia



Source: Horizon Power (2018)²¹⁹

New technologies can bring substantial benefits for remote users

Continued reductions in the price of solar and battery storage mean that smaller scale electricity generation, particularly solar PV, and small-scale battery storage are becoming increasingly cost-effective. This opens up the prospect of using self-contained renewable energy systems as a complement to, or substitute for, existing electricity supply arrangements.

The economic, social and environmental benefits of renewable energy systems can be considerable. The replacement of grid-connection with new stand-alone power systems based on solar photovoltaic panels, lithium-ion batteries, an inverter and backup diesel generator, can reduce the cost of supply, mitigate bushfire risk and improve reliability for consumers. Where communities are not connected to the grid, micro-grids, storage and demand response solutions can reduce the need for diesel generation, optimise energy generation and consumption, and improve reliability.

Development of renewable micro-grids can bring construction jobs, support for local business, reduced emissions and, depending on the location and relevant regulatory arrangements, reduced prices for electricity users or lower budgetary impacts of community service obligations. Renewable energy systems are also modular and scalable, allowing communities more choice and flexibility to adapt or expand based on their communities' changing energy needs.

Remote solar systems may also allow Aboriginal and Torres Strait Islander communities to use energy in a way that is more compatible with their cultural values. It can do so by reducing noise and pollution from diesel generators and the trucks required to bring fuels, while helping to combat climate change, and improving connection with earth and sky.²²⁰ ARENA and the Northern Territory government have initiated the Northern Territory Solar Energy Transformation Program that aims to install 10 megawatts of solar PV across 26 communities.²²¹

Renewable energy can bring benefits for the resources sector

Renewable generation and storage are being adopted in regional and remote Australia by the mining sector and local industry.

With electricity costs representing up to 40% of mine operations, many mining companies actively manage their energy requirements.²²² There is value in avoiding fluctuating wholesale electricity prices, given that spot prices for electricity can spike during tight supply periods. Australian miners, including members of the South Australian Chamber of Mines and Energy have committed to renewable energy deals in a bid to lower bills, increase sustainability and improve their profitability.²²³

Large scale renewable installations also reduce the need for imported fuels. Weipa bauxite mine in Queensland installed a solar plant that avoided the use of 600,000 litres of diesel each year.²²⁴ Coober Pedy power station eliminated the need for one million litres of diesel over a six month period in 2017 by installing solar generation with battery storage.²²⁵

Some mining operations are acting to change their electricity demand patterns across the day, to match solar generation. SunMetals zinc refinery in Queensland, which operates a 124 MW PV plant, coordinates its energy intensive electrolysis process to coincide with peak solar generation.²²⁶

Bruny Island Battery Trial has saved taxpayers costs without sacrificing reliability

Bruny Island is connected to Tasmania's main grid via an undersea cable, which overloads at times of peak demand. Rather than incurring the sizeable costs of upgrading the cable – which is estimated to cost \$1 million per kilometre – or installing diesel generators, residents have been provided with subsidies to install 40 battery and rooftop solar PV systems.

These batteries are used in a smart, automated way to reduce network costs, and deliver reliable and secure electricity. Battery owners maximise the value of their battery systems by exporting electricity when the need for energy is high. This shaves peak demand while keeping the network within voltage and capacity limits.²²⁷ Since energy

generation is more localised, there is less demand for distribution, reducing the cost of building, upgrading and maintaining poles and wires, thereby reducing costs to all electricity users.

Energy systems on Rottnest Island in Western Australia and King and Flinders Islands in Tasmania also have a high proportion of renewable energy assets, high system quality and reliability. Both projects have significantly reduced diesel consumption. Other remote communities and commercial operators with the appropriate characteristics, such as good solar and wind patterns, stand to benefit from integrating renewable generation and storage into their electricity system.²²⁸

147. Opportunity

There is an opportunity to leverage new local energy supply solutions that either replace or complement diesel generation in remote and regional areas. This can increase amenity, reliability and affordability for local communities and businesses.

When this
will impact:



Where this
will impact:





Regulation can affect the extent of the grid frontier

New technologies are particularly relevant at the edge of grid because the costs of providing a service are highest in these areas. However, in the absence of cost-reflective pricing for customers in remote areas, it is likely that many users will opt to stay on the grid.

Regulation of micro-grids is not applied consistently across all jurisdictions. In Queensland, remote users generally receive the same regulatory protections as NEM users.²²⁹ In contrast, the micro-grid on Lord Howe Island (New South Wales) is overseen by an independent board.²³⁰ Though not subject to NEM requirements, all tariffs, charges and retail conditions for the two micro-grids in the Bass Strait must be approved by the Tasmanian Economic Regulator.²³¹ In Western Australia, services provided to remote communities through around 200 micro-grids under the Remote Essential and Municipal Services program are unregulated.²³²

Other government policies can also impact regional and remote electricity users. Most jurisdictions operate a Guarantee Service Level scheme, which provides payments to customers in recognition of

poor service, including reliability.²³³ Though regional and remote customers receive such payments, funding for the schemes is shared with all users across the state or territory.

The regulatory framework currently constrains the ability for distribution businesses to transition edge-of-grid customers to stand-alone power systems. This could adversely affect decision-making about the best infrastructure solutions on the edge of the existing grids, and could impose extra costs for all users.

The AEMC is currently considering options to facilitate greater adoption of stand-alone power systems in circumstances where that would represent a more efficient solution to remaining grid-connected and where appropriate customer protections are in place. According to the AEMC, the numbers of customers that distributor network operators would seek to supply via stand-alone power system solutions might be relatively small in the context of markets as a whole – perhaps less than 10,000 over the next ten years.²³⁴ However, these customers account for a disproportionately high share of these distributors' costs, and transition to off-grid supply could result in significant overall cost savings for all customers.

148. Challenge

The current regulatory regime does not optimise emerging opportunities for energy supply to regional and remote communities via stand-alone power systems. Without regulatory reform, rural and remote users may not take up lower cost and more reliable energy solutions, and overall costs may be increased for all users and taxpayers.

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Where this will impact:



7.8 Harnessing Australia's energy advantage

At a glance

This section explores ways we can harness our vast energy sources by expanding research, attracting energy-intensive industries, and better accessing our abundant natural gas to meet global demand. By managing royalties and taxes well, all Australians can enjoy the benefits of growth in this sector.

This section explores opportunities to use hydrogen domestically and as an export, and to lower peak power demands by shifting use times.

Australia has immense energy resources

Australia is blessed with an abundance of key energy assets, both renewable and non-renewable, meaning it has the potential to be a new energy superpower.

The scale of resources available relative to domestic consumption requirements has made Australia one of the world's major energy exporters. Coal and uranium dominated exports for decades, later joined by natural gas. At home, we simultaneously used this abundance to form a comparative advantage for Australia in domestic energy costs, attracting energy intensive industries to our shores.

Few nations can lay a credible claim to having a massive energy surplus. Australia is one of them.

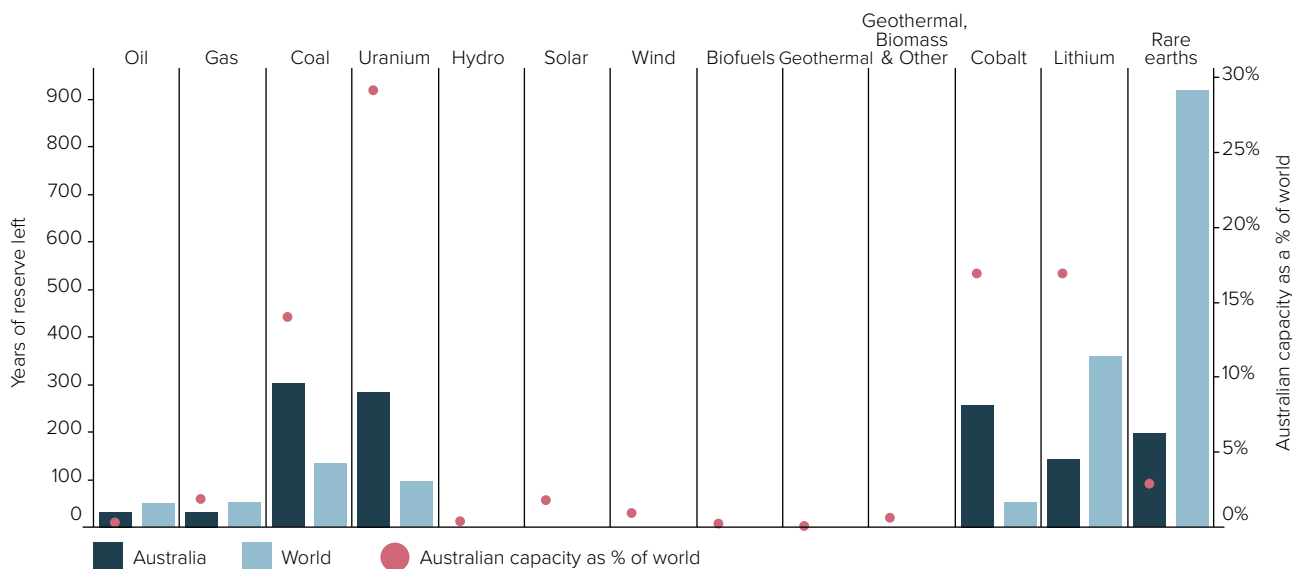
As the world gradually transitions its energy fuel mix towards lower emitting technologies for domestic electricity production, Australia has an opportunity to

take advantage of this transition as an even greater export opportunity, while concurrently returning to its position as a low-cost energy producer.

As Figure 34 shows, Australia produces a relatively small proportion of the world's renewable energy despite our opportunity, and has a relative abundance of battery minerals such as cobalt and lithium, which will likely be critical to our future energy system. The opportunity available to Australia by developing new exports from renewables and storage is major. Decoupling renewables development from needing to access the local transmission network has potential to unlock significant income and jobs for Australia.

We also retain a sizeable share of traditional fuels such as thermal coal, uranium and gas.

Figure 34: Australia has high energy potential for certain fuel types, compared to the rest of the world



Note: Years of reserve left indicates the length of time remaining reserves would last if production were to continue at existing rates. It does not apply for renewable sources. Oil, gas, and coal are based on proven reserves. Uranium is based on known recoverable resources. Hydro and geothermal, biomass and other are based on generation. Solar, wind, and geothermal are based on installed capacity. Biofuels is based on production. Cobalt, lithium, and rare earth are based on reserves.

Source: British Petroleum (2018), World Nuclear Association (2019)²³⁵

149. Opportunity

Australia could develop new industries based on cheap and abundant new sources of energy, including large-scale solar and wind. This could attract energy intensive industries to Australia, or allow export of products with high levels of embedded cheap energy. This may require wider use of existing infrastructure, and new infrastructure investment.

When this will impact:



Where this will impact:



Australia leads on sun and wind, but captures little on a worldwide scale

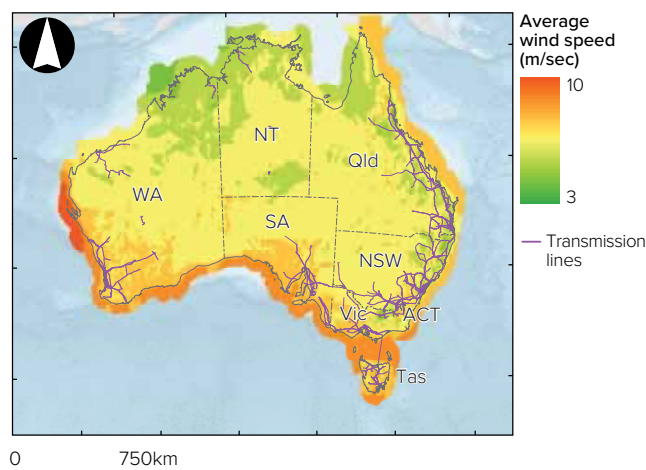
Geoscience Australia estimates that Australia receives solar radiation equivalent to approximately 10,000 times its total energy consumption.²³⁶ At this level Australia has the highest solar radiation per square metre of any continent. The highest yielding areas are the desert regions in the northwest and centre of the continent.²³⁷ Australia’s best solar resources are towards the north and west of Australia, while wind performs better in the south and along the east coast, as shown in Figure 35.

Our wind resources are most prevalent in the south of Australia – in the coastal regions of western, south-western, southern and south-eastern Australia – where winds (for example the “Roaring Forties”) are generally stronger, including around the Great Dividing Range on the east coast.

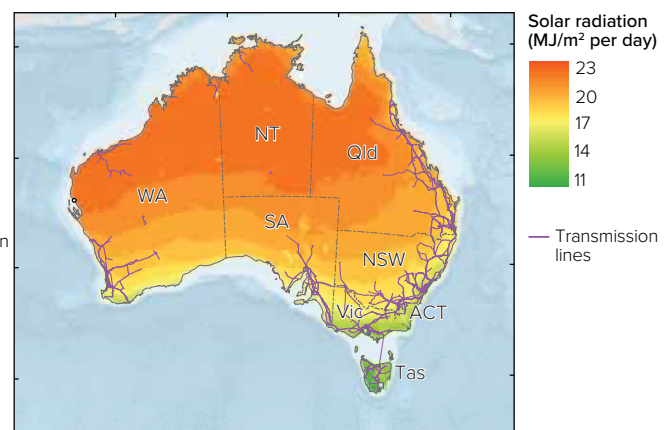
Harnessing these opportunities domestically is emerging as an opportunity to lower Australia’s energy prices. With planning, the export opportunity from low marginal cost energy could be significant.

Figure 35: Australia has abundant wind and solar resources

Wind speed



Solar radiation



Source: Geoscience Australia and Bureau of Resources and Energy Economics (2014)²³⁸

Research and development are important to unlock future opportunities

Unlike the fossil fuel resources which Australia has exported so successfully, directly exporting Australia’s wealth in renewables is economically not yet feasible, though new opportunities are being explored.

There is an emerging opportunity to export our abundant energy by converting it to hydrogen. This has been studied by the CSIRO, which has developed some of the technologies required to facilitate this trade.²³⁹ This would enable Australia to supply energy to trading partners such as Japan and South Korea, and assist with their path to decarbonisation.²⁴⁰ The hydrogen supply chain would require new renewable energy infrastructure, pipelines, compression and port infrastructure.



There may also be an opportunity to link the high-quality solar resources in Australia's North West to Indonesia using a High Voltage Direct Current (HVDC) undersea cable.²⁴¹ Indonesia's population is over ten times larger than Australia's, in a land area less than a quarter the size. Similar to the link connecting Tasmania to the mainland, it would add yet another lucrative export product to the existing iron ore and LNG industries operating out of that area.

Hydrogen also has the potential for domestic use. Trials have shown that existing gas pipelines can accommodate hydrogen for up to 10% of their transported gas with no physical changes,²⁴² providing a potentially lucrative alternative destination for renewable generation facilities. Energy Networks Australia has identified that hydrogen injection into Australia's LNG network could reduce carbon emissions from gas use. While conversion of electricity to hydrogen is not particularly efficient (output efficiency today is as low as 30 to 40%)²⁴³ this is likely to improve over time.

Demand for gas is growing across global markets

Natural gas has been a source of relatively low-cost energy production in Australia over past decades. While for many years this was largely drawn from the Bass Strait and the Cooper Basin, development of Liquefied Natural Gas (LNG) technologies and hydraulic fracturing (fracking) have unlocked large quantities of natural gas in other parts of the country.

As shown in Figure 36, the span of proven gas reserves is broad. Projects such as Prelude, Gorgon, Wheatstone, and Darwin LNG among others are seeing tens of billions of dollars of investment directed towards regional and remote areas, particularly in northern Australia. In 2017, the ACCC estimated that well over 60% demand for LNG in the east coast gas market was export demand.²⁴⁴ This has seen new infrastructure such as pipelines, ports and LNG facilities created in western, northern and north-eastern Australia in the past decade.

Combined, fracking and the many LNG terminals have made Australia the world's largest exporter of natural gas in recent years, exceeding Qatar.²⁴⁵ The lower emitting nature of gas for energy production makes it particularly attractive as the world moves to limit carbon emissions, and Australia is optimally positioned to take advantage of this trend. The new LNG terminals enabled this export opportunity for Australia.

150. Opportunity

Australia could leverage its energy resources to provide global leadership and innovation on energy research and development through its high-quality research and education institutions. New discoveries and lower costs can provide Australia with an advantage on applied energy use, supporting new industries.

When this
will impact:

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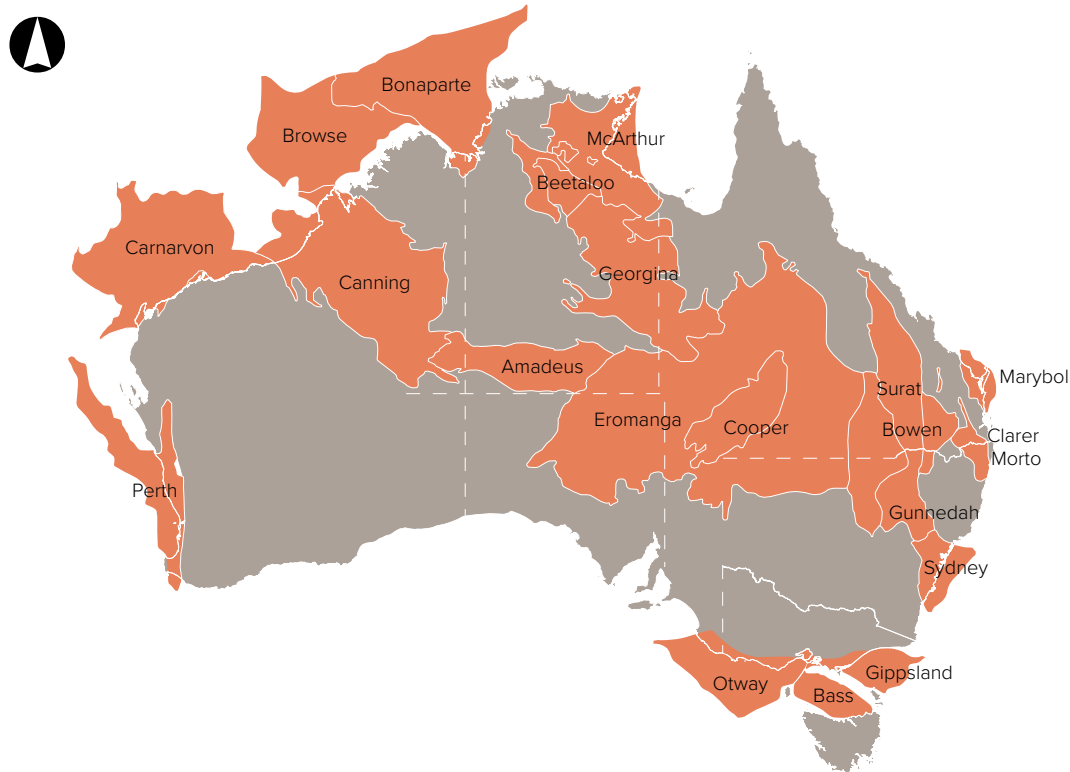
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will impact:



Figure 36: Australia’s Natural Gas Resources are spread across much of the countrySource: Icon Energy (2013)²⁴⁶

Under current settings, much of eastern Australia’s proven reserves of natural gas cannot be exploited following a series of broad-based moratoriums and outright bans on exploration and mining using hydraulic fracturing. Some of the early exploration and extraction practices were reckless. However,

recent studies have found that fracking, when done properly, can be both safe and cost-effective, and that Australia’s regulatory structures are well-equipped to protect local environments and communities.²⁴⁷

151. Opportunity

Australia’s regions have significant reserves of onshore gas. However, there are restrictions on accessing reserves across many regions. Unlocking these reserves could provide substantial export growth potential, as well as opportunities for lower prices for domestic users.

When this will impact:

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Where this will impact:



7.9 Challenges and opportunities

Affordable and competitive energy

133. Challenge

Transparent and affordable electricity prices are essential to reducing pressure on household budgets, particularly for lower income households. A continued rise in energy bills will place an added burden on many households and may reinforce inequality. Ongoing complexity of bills will add to user costs and frustrations.

When this will impact:



Where this will impact:



134. Challenge

Regaining energy price competitiveness is important for lower business costs and improving productivity of Australian firms. Australia risks becoming uncompetitive in some energy intensive industries due to rising energy costs.

When this will impact:



Where this will impact:



Secure, reliable and sustainable energy

135. Challenge

Balancing reliability and affordability in line with users' willingness to pay will be an ongoing challenge in energy systems with rapidly transforming wholesale and network characteristics. Failure to get the balance right will result in higher costs for users due to inefficient investments, or poorer reliability for users.

When this will impact:



Where this will impact:



136. Challenge

Governments, regulators, operators and service providers need to manage growing risks to Australia's energy systems and fuel sources, including risks from climate change, cyberattack or disruptions to fuel supply. Failure to effectively mitigate against risks to energy services could have substantial consequences for the economy.

When this will impact:



Where this will impact:



137. Challenge

Despite positive progress on the development of a national climate policy, ongoing politicisation of the issue and policy inconsistency between levels of government reduce market certainty. Uncertainty prevents timely investment in long-term infrastructure such as electricity generation and gas pipelines, increasing risks and costs to users.

When this will impact:



Where this will impact:



Transitioning to Australia's future energy fuel mix

138. Challenge

Many major coal generation assets are ageing and approaching retirement. The capacity they provide will need to be replaced. In the NEM, this capacity needs to be replaced or there may be impacts on reliability or competition. In the WEM, where there is overcapacity there may be scope to reduce surplus capacity. In both cases, there is a risk to the order of the market.

When this will impact:



Where this will impact:



139. Challenge

As the penetration of small- and large-scale renewables increases across the network, additional investment in networks and generation will be required to manage reliability and service levels. This will increase capital and operational costs in networks, but will be needed to maintain balanced supply standards.

When this will impact:



Where this will impact:



140. Opportunity

New forms of large-scale storage are increasingly available, including pumped hydroelectric and battery assets. Introduction of appropriate new firming capacity will complement variable renewable energy bids and aid the transition to the new electricity mix.

When this will impact:



Where this will impact:



Planning for our future energy networks

141. Challenge

Transmission networks need to respond to new generation in areas not currently served or without sufficient spare capacity. The outcome of these decisions will be paid for by users over many years. It is in the interests of users that the transition is efficient and guided by well-targeted investment.

When this will impact:



Where this will impact:



142. Opportunity

Coordinating investment in new generation and network assets in Renewable Energy Zones can promote investment in renewable generation, provide clarity for network investors, and increase scale and lower costs for new generation providers. Optimising investment in Renewable Energy Zones will lead to lower wholesale and network costs for users over time.

When this will impact:



Where this will impact:



New opportunities for consumer choice

143. Challenge

Home solar and storage can help users to save costs and control energy use, but government policies are uncoordinated. Developments in behind the meter energy systems risk leaving some users behind, while uncoordinated policies and subsidies add to costs over the long term.

When this will impact:



Where this will impact:



144. Opportunity

Demand response from users can defer or avoid expensive new electricity infrastructure investment, and better use existing infrastructure. This can save users the passed on costs of higher peaks.

When this will impact:



Where this will impact:



145. Opportunity

Electric vehicles could provide additional storage capacity to stationary electricity systems. There are regulatory and technical barriers to be overcome. This may provide a means of converging stationary and non-stationary energy at household level.

When this will impact:



Where this will impact:



Delivering energy in remote communities

146. Challenge

The costs of serving remote and regional areas remain high, with customers in those areas also often receiving poor reliability outcomes. Poor energy reliability in remote areas undermines quality of life and opportunities for growth and investment.

When this will impact:



Where this will impact:



147. Opportunity

There is an opportunity to leverage new local energy supply solutions that either replace or complement diesel generation in remote and regional areas. This can increase amenity, reliability and affordability for local communities and businesses.

When this will impact:



Where this will impact:



148. Challenge

The current regulatory regime does not optimise emerging opportunities for energy supply to regional and remote communities via stand-alone power systems. Without regulatory reform, rural and remote users may not take up lower cost and more reliable energy solutions, and overall costs may be increased for all users and taxpayers.

When this will impact:



Where this will impact:



Harnessing Australia's energy advantage

149. Opportunity

Australia could develop new industries based on cheap and abundant new sources of energy, including large-scale solar and wind. This could attract energy intensive industries to Australia, or allow export of products with high levels of embedded cheap energy. This may require wider use of existing infrastructure, and new infrastructure investment.

When this will impact:



Where this will impact:



150. Opportunity

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When this will impact:



Where this will impact:



151. Opportunity

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When this will impact:



Where this will impact:



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8

Telecommunications

Telecommunications infrastructure covers the networks that carry voice and data between users across Australia, and our connections with the rest of the world, impacting on our liveability and productivity.

This includes wires, fibre, towers, sensors, satellites, radio spectrum and physical infrastructure such as data centres and cable landing stations, which come together as networks to deliver communications to and from our devices, whether we live and work in fast-growing cities or remote communities.

The inclusion of a federal regulatory power over 'telephonic, and other like services' in Australia's Constitution in 1901 means that, since Federation, telecommunications is the only broad public infrastructure sector with an overarching national character.¹ Australia's first telephone call was made just over 20 years earlier in 1879.² Telecommunications have since grown, with the help of significant technological advancements, to support the entire economy, and influence how we live our lives.





8.1 Introduction



The state of the telecommunications sector

- Telecommunications is more central to our lives at home and work than it has ever been.
- Significant investment is occurring in the telecommunications sector, responding to growth in demand for data-driven services and new uses for telecommunications.
- Generally, consumers are positive about quality and access to networks but are concerned about paying more.
- There are opportunities to improve the telecommunications services for the digitally disadvantaged, and for rural and remote communities and businesses.
- The specific needs of rural and remote users are often overlooked in upgrades to national telecommunications infrastructure.



Telecommunications is more central to our lives than it has ever been

Telecommunications is increasingly central to our personal lives and to the way we work and do business. It is becoming ubiquitous. Business and government are rapidly moving services online. As almost all of us rely on these services, access to networks that keep us connected is becoming essential.

Almost 90% of Australians accessed the internet through their mobile phone in 2018.³ Some 59% of Australians now use four or more devices to access the internet.⁴ On average, Australian adults spent over two full days per month accessing content on their smartphones in 2018.⁵

Telecommunications networks are constantly evolving

Of all infrastructure sectors, telecommunications is today the least recognisable sector from a generation before. Change is set to continue, as we are in the midst of the construction of Australia's fixed line broadband network, and on the cusp of investment in a new generation of mobile networks.

Most of the telecommunications infrastructure in Australia is privately owned. The notable exception is the publicly-owned National Broadband Network (nbn), which is still under construction but has begun delivering services to users. The nbn network was designed to ultimately become the predominant wholesale provider of fixed line access services.

nbn's governing legislation contemplates a change of ownership, from public to private hands, after it is built. With the nbn rollout due to be completed in 2020, how this major investment is utilised, upgraded and ultimately integrated with services from the private sector will significantly impact Australia's telecommunications accessibility, quality and affordability.

nbn is solely a wholesale provider of broadband services, and sells access to its network to over 150 large and small retail service providers nationally,⁶ including major players such as Telstra and Optus, and smaller retailers such as Bendigo Telco, Central Coast Internet and Telecom West.

In the mobile service area, the three major mobile network operators (MNOs) are Telstra, Optus and Vodafone. These operators sell access to their networks to a range of over 50 other mobile service operators.⁷ These retailers are often active in particular parts of the country.



The nbn network rollout continues and we are on the cusp of building new 5G networks

Australians' use of fixed broadband and mobile data has increased by 175% and almost 250% respectively, since 2015, but with 93% of the data delivered via fixed broadband.⁸ These are growth rates many times faster than our economy overall.

The 2015 Audit indicated the transformative role the nbn would play in Australia's future telecommunications landscape, and this promise holds true. In 2015, the Audit noted that 818,000 premises were nbn ready (about 7% of all premises), and that 346,000 had connected to the service by February 2015 (3% of premises). Today, the nbn is over half way to its target of delivering peak wholesale download data rates of at least 25 megabits per second to all premises, and 50 megabits per second to 90% of fixed line premises by 2020.⁹ By March 2019, 8.8 million premises (around three quarters of all premises) were ready to connect to the network, and 5.1 million were already connected.¹⁰

In 2015 we focused on 3G and 4G mobile services. In 2019, 2G and 3G mobile networks are largely obsolete, while there is significant ongoing private investment in 4G network upgrades. The arrival of 5G networks is on the horizon, with trials having begun already, and the likely step change is substantial.

Australians are positive about quality and access to networks but are concerned about paying more

Consumers are generally positive about the quality of their telecommunications services.¹¹ However, significant issues remain in rural and remote areas for mobile and broadband services.

There is a stronger positive view about the ease of access to telecommunications services, although once again, rural and remote Australians are less positive about their experience.¹²

Consumers broadly see their telecommunications services as more costly than affordable, and there is resistance to paying more,¹³ even as providers of broadband and mobile data services are increasing data quotas.

Maximising opportunities for the digitally disadvantaged is a challenge

The Australian Digital Inclusion Index (ADII) is an annual survey of Australians' access to, and ability to access, digital resources. It provides a key success touchstone of telecommunications access universality, with the record to date indicating there is more progress to be made.¹⁴

Income, age, disability, education and Aboriginal and Torres Strait Islander status are all factors that influence levels of digital inclusion. For particular groups, the challenge is how to both increase digital

literacy where infrastructure already exists, and to make telecommunications access affordable. This is important given its inherently regressive nature imposes costs on those who do not need wholesale internet connectivity to the benefit of the most resource intensive users.

Geography also matters. In rural and remote settings, the cost of providing telecommunications infrastructure increases and the returns reduce as population densities decline. In some cases, this limits the scope for universal coverage by commercially-focused private sector operators, without government intervention.

In this chapter

To identify and examine the key telecommunications infrastructure challenges and opportunities in Australia, this chapter focuses on four major themes:

8.2 Telecommunications enable productivity and innovation considers how telecommunications infrastructure can support new services for businesses and people.

8.3 The mobile coverage dilemma looks at Australia's strengths in the provision of mobile services, and the challenges and opportunities presented by a pending 5G step-change.

8.4 Maximising the benefits of nbn investment considers how we can capitalise on this one-in-a-lifetime investment by Australian taxpayers.

8.5 Social inclusion and affordability for telecommunications services explores the challenge of extending connectivity to those Australians at risk of being left behind in the digital world, and assess user affordability issues for consumers and businesses.

Performance of the sector



Quality

Australia ranks

4th

on mobile broadband speeds in June 2019 ¹⁵



Access

1 in 10

adults did not access the internet at least once in the six months leading to May 2018 ¹⁷



Access

15% vs 32%

Change in proportion of users with monthly mobile data allowances over 10GB in one year to 2018 ¹⁸

Access

91%

of all data that is consumed is on **fixed broadband** ¹⁶

Quality



Quality

9 points

Gap between cities over rural areas in performance on Australian Digital Inclusion Index ¹⁹

88%

Average percentage of maximum plan speed delivered to customers using **nbn fixed broadband** services ²⁰

Cost



6.2% vs 2.2%

Proportion of income spent on telecommunications by **lowest earning 20%** of the households versus **highest 20%** ²¹

Quality



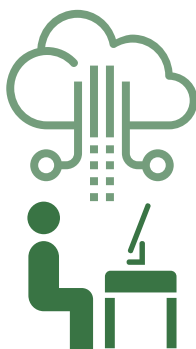
80%

Proportion of adults **concerned about** how their data is used by companies ²²

Access

73%

of businesses are already **using cloud computing** for data storage ²³



Cost

Telecommunications comprises

14%

of average household infrastructure costs ²⁴



Cost



44%

Proportion of consumers that rate fixed broadband as costly ²⁵

Scale of the sector

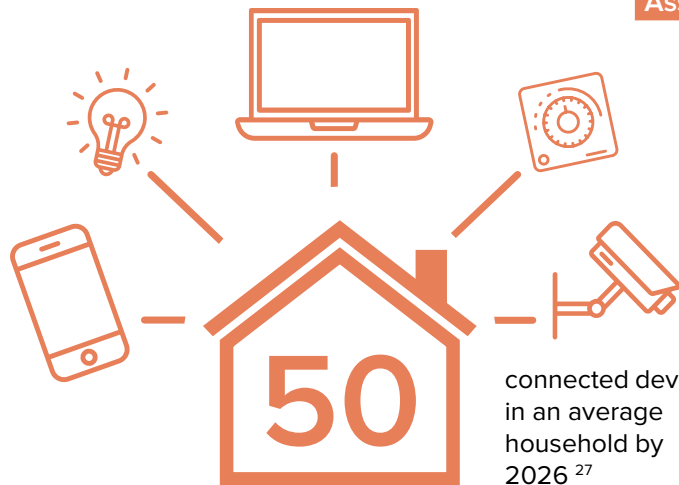
Customer



26.9 million

mobile handset subscribers in Australia ²⁶

Asset



connected devices in an average household by 2026 ²⁷



Asset

11.7 million

premises will be ready to connect to nbn by mid-2020 ²⁸

Access

Australia ranks first for key enablers of mobile internet takeup ³¹



Industry

\$1.78 billion



Annual community service obligation subsidy in telecommunications ³²

Customer

340%

Estimated growth in household data usage between 2016 and 2026 ²⁹

Access

14%

Estimated proportion of nbn-ready households using fibre to the premises at the end of the rollout ³⁰

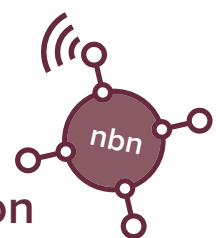
Access



70%

of regional households will have access to a fixed broadband connection at the end of the nbn rollout ³³

Customer



5.5 million

Estimated premises connected via the nbn network by mid-2019 ³⁴

Industry

867

Mobile black spot base stations part-funded by government ³⁵



Asset

99.4%

of the population are able to access mobile services at home ³⁶

Industry

Telstra's shares in 2016

41%

of mobile phone market



51%

fixed broadband ³⁷



8.2 Telecommunications enable productivity and innovation

At a glance

Opportunities are emerging in telecommunications, with generational leaps in fixed line and mobile networks. But to be effective in meeting user needs, our networks must be fit for purpose. We lead the world in mobile telecommunications, but our broadband speeds lag far behind.

This section explores the technology that will support productive growth, particularly the National Broadband Network (nbn) and 5G mobile networks. By focusing on end users and spreading the benefits widely we can ensure no Australian is left behind.

The section also looks at growing threats to cybersecurity and our need to protect user privacy.

Digital development is happening apace

Over the last thirty years, Australia and the world have been on a digital journey, which has occurred in three waves. Each has been driven by new technologies, escalating connectivity and flows of data (Figure 1). Our evolving telecommunications infrastructure networks have enabled these waves of change in services. Fixed line networks include dial-up internet, which has now progressed to broadband through cable, digital subscriber line (DSL), fibre (including access, backhaul and dark), and subsea cable infrastructure. Wireless networks include radio, mobile networks (which have progressed through generations from 2G and 3G, now into 4G and 5G), satellite, and Machine to Machine (M2M) and Internet of Things (IoT) networks.

While Australian consumers are globally regarded as early adopters of new technologies and services, Australian businesses and governments do not have a strong record for innovation. Australia's large companies ranked 21st out of 32 OECD countries on

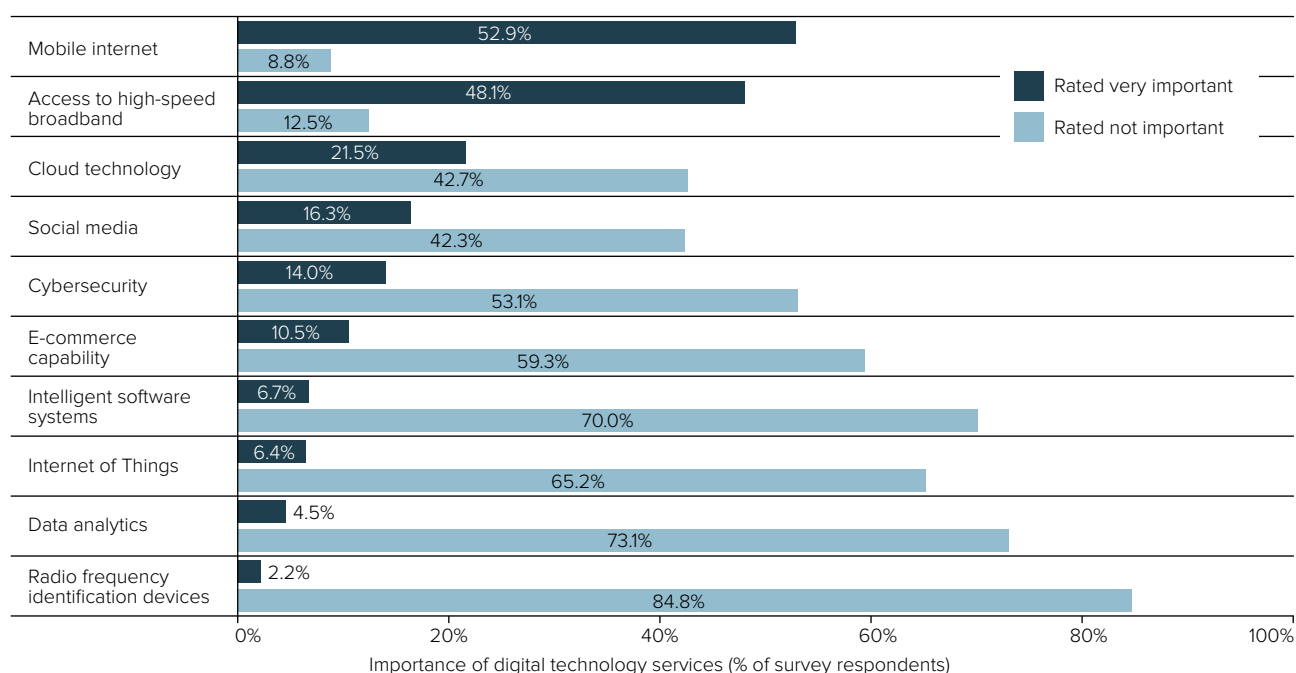
the proportion of businesses innovating, below other resource-exporting countries like Brazil and South Africa.³⁸

Australian Bureau of Statistics (ABS) data for 2015-16 showed mobile internet and access to high-speed broadband as clearly the two most important digital technologies according to Australian businesses (Figure 2). While other technologies are also rising in importance, effective fixed and mobile broadband infrastructure remains essential to improving performance by businesses, and in meeting consumers' evolving needs.

To manage the growth in data to and from Australia, there has been continued investment in subsea cables with three new subsea cable systems deployed in 2018 bringing significant new capacity. In addition, there has been significant investment and continued growth in data centres across Australia as companies continue to move their data and IT systems to the cloud.

Figure 1: Transformative digital development has been occurring for the past 30 years

Wave 1: Automation	Wave 2: Connectivity	Wave 3: Business applications
1990s to 2000s	2000s to 2010s	2010s to the present
<ul style="list-style-type: none"> • Desktop computing • Internet • Search engines 	<ul style="list-style-type: none"> • High-speed broadband • Smartphones, laptops and tablets • Cloud storage and computing • Social media • The Internet of Things (IoT) 	<ul style="list-style-type: none"> • Artificial intelligence and machine learning • Advanced robotics • Additive manufacturing • Distributed ledgers • Virtual and enhanced reality • Mobile applications • Supercomputing

Figure 2: Businesses rate telecommunications backbone services very highly

Source: Australian Bureau of Statistics (2017)³⁹

Telecommunications infrastructure supports economic growth

Telecommunications infrastructure networks play a critical role in supporting Australia's economic productivity. This role is increasing as our economy becomes more reliant on digital technology and connectivity.

The nbn alone was estimated to generate \$1.2 billion per annum in additional GDP in 2017 through new jobs, new businesses and increased productivity.⁴⁰ This is expected to grow to over \$10 billion by 2021.⁴¹ 5G technology is also likely to improve Australia's economic productivity by enabling fast signal speeds (lower latency), which underpin responsive technologies and applications, such as robotics. Conservative estimates calculate the contribution of 5G technology to GDP at \$1,300 to \$2,000 per capita after the first decade of rollout.⁴² These estimates do not take into account the full consumer and non-market benefits, or potential benefits from distributional effects within and between industries.

There are also significant potential gains from 5G uptake in industries with low existing telecommunications technology intensity. IoT technologies and services are estimated to provide an annual boost to five key industries (construction, manufacturing, healthcare, mining and agriculture, fishing and forestry – representing around one-quarter of our economy today) of between \$200 billion and \$300 billion.⁴³ The largest gains are expected in the construction industry, where a large amount of technical equipment is used, but adoption has been slowest to date.⁴⁴

Governments, businesses and households are already embracing new technology

Evolving telecommunications infrastructure is already enabling governments, businesses and households to leverage new technologies to increase access to information, improve efficiency in service delivery, boost economic productivity and improve liveability. For example:

- **Governments** are using new technologies in health, education, smart cities and public safety applications. Online platforms are increasingly used to deliver services to citizens – examples are the Australian Government's MyGov and Western Australia's ServiceWA. At local government level, waste contractors have been using Radio Frequency Identification (known as RFID) technology for a decade, improving route management and allowing weighing of waste by household and to identify out of location bins.⁴⁵
- **Businesses** are embracing cloud computing, IoT, artificial intelligence and advanced robotics. Cloud storage and computing are reducing business costs. Businesses and governments are rapidly embracing cloud-based solutions to garner benefits including reduced hardware costs, mobile accessibility, and savings on security and redundancy. In 2017-18, Telstra reported an increase in cloud revenue of 14.4%.⁴⁶
- **Households** are becoming smarter as they embrace new technologies aimed at improving convenience and automating processes. This includes IoT technologies such as virtual assistants, smart lights, heating, air conditioning and security systems.

The Internet of Things

The IoT is a collection of internet-connected devices that are added to things – objects, infrastructure, places or worn by people.

These devices communicate with one another quickly and reliably, sending and receiving information, and in some instances controlling aspects of objects. This enables automation of a wide range of household and business processes, from smart watches and smart home applications such as virtual assistants, to autonomous vehicles, to sensors tracking hospital bed use, and autonomous drones carrying out predictive maintenance on remote infrastructure assets.

The Australian Communications and Media Authority (ACMA) quotes industry estimates that 29 billion devices will be connected worldwide by 2022, over 60% of which will relate to the IoT.⁴⁷

While many IoT devices already operate today, the introduction of 5G networks in Australia will accelerate the growth of the IoT in Australia. 5G networks will provide greater speed and higher data rates to increase the capacity of IoT technology, which will drive its uptake across a range of industries. The Bureau of Communications and Arts Research (BCAR) has estimated that the average Australian household will have at least 50 IoT devices by 2026. Other estimates anticipate double that amount.⁴⁸

Supporting the Internet of Things in cities and regions

Telstra is deploying two technologies to significantly expand its IoT coverage in buildings and wide areas.

Cat-M1 operates on the 4G network and enables IoT devices to have greater reach in distance and depth into buildings. Cat-M1 supports devices that by their nature are low complexity which makes it suitable for a variety of uses across agriculture as well as utilities, healthcare and supply chains. Coupled with range extension capability, Telstra provides customers with a Cat-M1 enabled device with a network footprint that is around three million square kilometres in area and penetrates far deeper into city buildings than 4G coverage has previously.

Narrow Band IoT (NB-IoT) targets both outdoor and deep indoor coverage, supporting long battery life. Uses include livestock and crop monitoring. In 2018, Telstra tested a long-range NB-IoT connection, a step towards increasing Telstra's mobile footprint in rural and regional Australia. With this new capability, enabled with a software upgrade, Telstra's NB-IoT coverage will increase to more than 3.5 million square kilometres (about 45% of Australia's landmass).⁴⁹

152. Opportunity

Digital technologies are using telecommunications networks to enhance Australia's economic productivity. Embracing these new technologies can be a source of competitive advantage for Australia and can improve outcomes for users.

When this will impact:



Where this will impact:



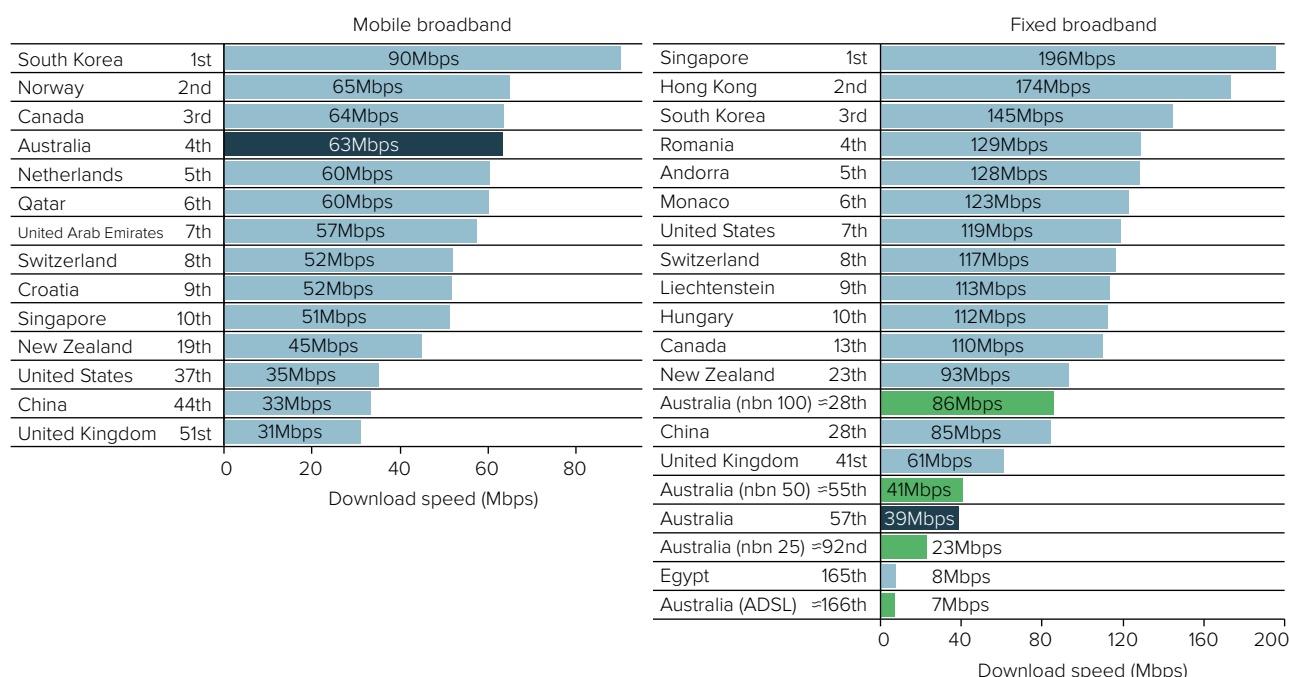
Australia leads on mobile speeds but lags on fixed broadband speeds

Australia is widely considered a world leader in mobile telecommunications. This is supported by Australia's 'Leader' ranking in the GSM Association Mobile Connectivity Index.⁵⁰ As Figure 3 shows, we rank 4th in the world for average mobile broadband speeds. However, our fixed internet speeds are much slower. In June 2019, we ranked 57th in the world on fixed broadband speeds, well behind comparable

developed nations.⁵¹ While the top nbn speed tiers place us at the equivalent of 28th in the world, our ADSL speeds place us closer to 166th.

At the same time, demand for data, particularly mobile and wireless broadband, is increasing apace. For example, mobile handset data consumption increased by 41% between June 2017 and June 2018, and wireless broadband data consumption increased by 49% over the same period.⁵² Australia will need to continue to deliver increasing amounts of data, at high speeds, into the future to meet this demand.

Figure 3: Australia performs well on mobile speed rankings, but poorly on fixed broadband speeds



Note: Fixed broadband speeds for nbn speed tiers and for ADSL (green bars) are average busy-hour download speeds during May 2019. The ranking for these entries show where these speed tiers would sit on the international rankings. The dark blue bar for Australia represents performance across all internet connections nationally.

Source: Ookla (2019), Australian Competition and Consumer Commission (2019)⁵³

153. Challenge

Australia's comparative performance for fixed broadband speeds is poor, and we lag well behind comparable nations. Failure to rapidly improve speeds could be a constraint on boosting productivity and liveability, and attracting businesses that require high levels of digital access.

When this will impact:



Where this will impact:



Focusing on users is critical

Reflecting strong competition in the market, mobile service providers continually strive to understand and meet user needs in terms of network coverage and quality, price, data allowances and customer service. The ‘use case’ focus (that is, a focus on specific applications where a product could be used) of 5G development suggests this will continue for the new generation technology and its associated applications.

The vertical separation of the majority of fixed broadband supply – wholesale nbn and separate retail service providers – risks less effective customer focus and service differentiation, as nbn operates at a distance from users, and retail services providers are restricted in their service offerings to the speed tiers and wholesale products that nbn delivers.

While most Australian consumers and businesses enjoy access to the range of telecommunications services, this is not the case for all. Rural and remote areas, and certain demographic groups, risk being left behind digitally.

While Australia’s mobile footprint includes over 99% of the population (at their premises), it covers only one-third of total landmass, meaning little or no service for those working and travelling in rural and remote areas. IoT networks are likely to have more extensive coverage than mobile data due to longer signal ranges, but still leave large parts of the continent uncovered.

Securing networks requires protecting data and balancing privacy

Cybersecurity is the practice of defending networks from malicious attacks. It involves commitment and action across sector regulators and participants, and requires proper governance, capacity building and cooperation. Australia has a strong international standing on cybersecurity. In 2017, the International Telecommunications Union placed Australia in the top ten for preparedness of the 162 countries surveyed, ahead of Canada and France but below the leaders Singapore and the United States.⁵⁴

Data governance is management of the integrity, use, availability, useability, and security of digital data owned or controlled by individuals, companies and governments. Australia’s data privacy regulation and enforcement has been rated as “heavy”.⁵⁵ The Privacy Commissioner has the power to initiate and conduct investigations, ensure compliance with the *Privacy Act*, and seek civil penalties for serious or repeated breaches of the Privacy Principles where remediation has not been implemented.⁵⁶ There is also sector-specific consumer data right regulations being implemented to empower consumers on use of their data, initially being implemented for banking.⁵⁷

Nonetheless, in a 2018 survey, Deloitte found over 80% of Australian adults surveyed expressed concern about how their personal data is used, stored and shared as a result of their online interactions with companies.⁵⁸ In 2016, Deloitte surveyed industry use of the latest regulatory compliance approach.⁵⁹ The best-ranked sectors were banking, finance, government, energy and telecommunications. Lower-rated sectors were retail, social media, media and real estate.

While Australia ranks highly on cybersecurity and data governance, community concern is high and cybercriminal techniques are constantly improving. As such, cyber-related policy and regulation need to continually stay ahead of new threats and reflect escalating data prevalence and importance.

154. Challenge

Cybersecurity risks, such as data privacy and system resilience, are growing as more Australians use more interconnected digital services. Failure to manage these risks could affect user engagement with new services, and reduce the potential benefits of these services. Network efficiency could also suffer.

When this
will impact:

0-5

5-10

10-15

15+

Where this
will impact:



8.3 The mobile coverage dilemma

At a glance

While Australia's mobile footprint includes over 99% of the population, it covers only one-third of total landmass, meaning there is limited service in particular rural and remote areas, for example along transport corridors.

5G mobile technology provides a potential step change in mobile telecommunications infrastructure for Australia, offering huge benefits including faster mobile data, minimal delays and the ability to separate services on the same network. However, the cost of rolling out 5G is high, and without a change in prioritisation, existing issues may be exacerbated in rural and remote areas.

This section also looks at how we allocate mobile spectrum. This is a finite resource that underpins mobile telecommunications, and affects service quality and cost.

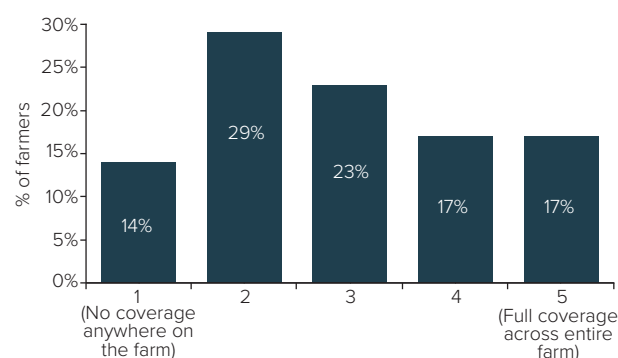
Mobile coverage prioritisation creates challenges in rural and remote Australia

While Australia has among the fastest mobile networks speeds in the world, coverage across the country is a challenge. This is because, while Australia's mobile footprint includes over 99% of the population, it covers only one-third of total landmass. Mobile network coverage, quality and choice of providers therefore remain significant issues in parts of rural and remote Australia.

Delivery of new and upgraded mobile coverage is prioritised where population densities are highest – places where people live and businesses are located. While coverage in these places is essential and contributes to improved liveability and productivity, this prioritisation results in limited coverage in other crucial areas with lower population densities, such as along transport corridors, or in large landholdings away from homes and businesses, such as farms and stations.

A 2017 study led by CSIRO showed that more farm respondents (43%) reported 'poor to no coverage' across their farm, than those who reported 'good to full coverage' across their farm (34%) (Figure 4).⁶⁰ This difference is likely to reflect the combination of size of farms and proximity to urban centres (where mobile base stations are typically located).

Figure 4: Farmers have varying levels of coverage across their properties



Note: Respondents were asked "How do you describe your mobile coverage across your entire farm?"

Source: Zhang et al. (2018)⁶¹

Mobile network coverage, quality and choice of providers remain significant issues in rural and remote Australia. Australian major cities and inner regional areas account for 88.6% of the population yet only cover 3.5% of the total landmass.⁶² BCAR has observed that for approximately one million square kilometres (around 13% of Australia's total land area), Telstra is the only available mobile network, although this area includes less than 1% of the Australian population (Table 1).⁶³

Table 1: 3G and 4G population coverage is high, but the last 1%-2% of population have no service or lack choice

Provider	3G coverage	4G coverage	Area covered by network	
	% of population	% of population	km ² (millions)	% of Australia area
Telstra	99.3%	98%	2.4	31%
Optus	98.5%	95%	1.0	13%
VHA (Vodafone)	97%	96.9%	0.9	12%

Note: VHA coverage includes roaming agreement with Optus.

Source: Australian Competition and Consumer Commission (2016)⁶⁴

The Australian Communications Consumer Action Network, which represents smaller users, notes that rural and remote users have lower access to emergency communications, including on major roads.⁶⁵ In their view, this is partly because valuation of remote emergency services is limited, which constrains investment cases to more densely populated areas. They refer to the lack of investment in passive dishes, as has occurred in some parts of the Northern Territory, despite the cost of each being lower than projects funded under other government programs.⁶⁶

Regional Australians have seen a focus on mobile black spot locations through a range of federal, state and territory funding schemes. The Australian Government's Mobile Black Spot program brings state and local governments together with Optus, Telstra and Vodafone, along with local businesses and communities to invest in infrastructure to improve mobile coverage and competition across Australia.

While the program has successfully delivered over 1,000 new base stations,⁶⁷ there are a range of challenges with this program, including:

- Prioritisation of funding based on residential population density, rather than an assessment of social or economic need.
- A lack of coordination of co-location and shared infrastructure, such as towers, to maximise choice of networks for users.
- The need for a more comprehensive evidence base on mobile coverage, to improve decision making around the placement of new mobile infrastructure.⁶⁸

In Victoria, the Connecting Regional Communities Program includes a range of regional initiatives to address digital black spots in nine regions. One example is the Regional Rail Connectivity project, which aims to provide commuters with end-to-end internet mobile connectivity across five regional rail lines – Geelong, Ballarat, Bendigo, Traralgon and Seymour – through the deployment of cellular repeaters installed on regional trains. Similar regional city and town focused projects are underway in New South Wales, Western Australia and the Northern Territory.⁶⁹

155. Challenge

Prioritisation of mobile network upgrades in rural and remote areas creates gaps in crucial areas, such as on productive land and along transport corridors. Failure to deliver services to these areas affects community safety, liveability and productivity.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



5G provides a step change for our mobile telecommunications infrastructure

5G technology offers a step change from the functionality provided by 4G networks. 5G data speeds are expected to be at least one and a half to two times faster than current 4G speeds, which is up to ten times faster than initial 4G networks.

The benefits of 5G for users include:

1. **Faster data speeds:** 5G will provide much faster mobile data speeds for uses such as media and entertainment, but could also allow newer technologies to be more widely adopted, such as augmented reality (where a computer generated view is overlaid on a real world view).
2. **Ultra-reliability and low latency:** greater reliability and reduced delays (lower latency) in networks speeds could provide significant benefits for sectors that require continuous, interactive, or precise telecommunications services. For example, in transport to connect autonomous vehicles, for some IoT uses in homes and urban environments, or in health for uses such as remote surgery.
3. **Network slicing:** the ability to segregate different services over the same network will allow service differentiation based on the actual use it supports, for example for essential services or autonomous vehicle networks.

Australia is well positioned as an early adopter for 5G technology

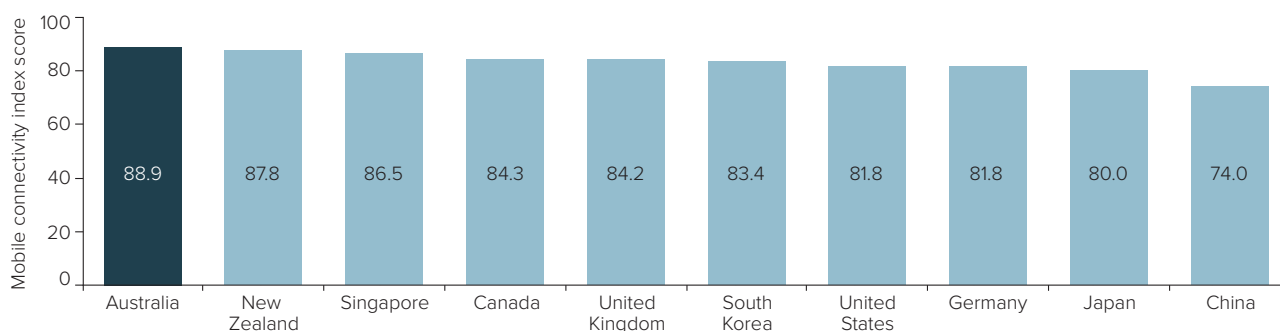
Australia is well positioned as an early mover in the rollout of 5G networks. We rank as the overall world leader in key enablers of mobile internet adoption according to the GSM Association (GSMA), a leading global industry body in the mobile sector.

The 2017 Mobile Connectivity Index, a leading measure compiled by the GSMA, compares Australia

against 162 other countries.⁷⁰ We rank at the top of G20 nations overall, in terms of infrastructure, affordability and consumer readiness (Figure 5). Australia has led the overall index every year since 2014. This suggests there is potential for 5G adoption to be stronger and faster than previous mobile generations in Australia.

Telstra, Optus and Vodafone have announced plans to build national 5G mobile networks, with launches expected from all three in 2019.

Figure 5: Australia leads key competitors on readiness for mobile adoption



Source: GSM Association (2017)⁷¹

156. Opportunity

5G technology presents an opportunity for Australia and we are well positioned to embrace it ahead of other nations. Delivering 5G networks will help to accelerate Australia's digital transformation, providing significant benefits to people, businesses and governments.

When this will impact:



Where this will impact:

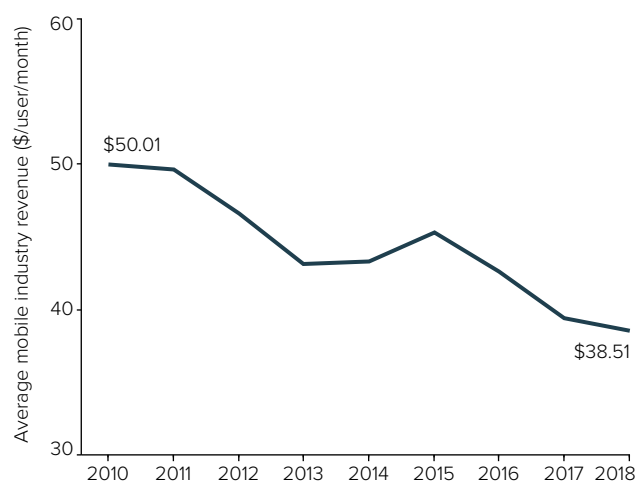


Mobile telecommunications is a highly competitive market

There is a significant amount of competition in the mobile industry. There are three major players (Telstra, Optus and Vodafone) as well as smaller operators who utilise these networks. Mobile products are increasingly commoditised and show little variation between providers. Price is the main decision factor for consumers as there is less differentiation arising from their mobile networks, coverage and customer experience. Unlimited plans are becoming more common, reducing differentiation on capacity.

Complicating the competitive landscape, average revenue per user is falling for mobile network operators (Figure 6). This may be associated with new applications, such as internet based services that act as substitutes (for example, Skype and WhatsApp), displacing revenue-generating voice and mobile message services. The decline in traditional revenue sources incentivises mobile operators to move into new markets.

Figure 6: Mobile industry revenue per user is falling (including handset)



Source: Venture Insights (2018)⁷²

Major operators are expanding free Wi-Fi in large and small cities

Traditional mobile services are also being displaced by expanding use of free Wi-Fi. Governments and MNOs are implementing Wi-Fi hotspots in public places across Australia, often for free, to maximise the potential of their network assets. Free Wi-Fi frequently offered to patrons in bars, cafes, and libraries complements mobile network coverage areas. For example, free Wi-Fi can now be found in shopping centres and in some CBD areas in cities.⁷³ TPG has provided backhaul to VicFreeWiFi in the Melbourne CBD, Bendigo and Ballarat, while Telstra's Wi-Fi network provides its customers with access to over one million hotspots across Australia.⁷⁴

These public networks are more readily available in our cities and regional centres and where existing infrastructure is prevalent and covers dense populations, lowering the cost of additional expenditure to improve capabilities. Lower teledensities outside of cities and towns means that there are areas with no mobile coverage, or only one provider (usually Telstra). This is reflected in Telstra's significantly higher market share in regional areas – particularly high in the non-urban parts of Tasmania and Western Australia.⁷⁵ However, new generation low Earth orbit satellites and high altitude platform stations (or high-altitude pseudo-satellites) may present opportunities to expand mobile coverage across much wider geographical areas, making these networks more economical in rural and remote areas.

Rolling out 5G could create cost and planning challenges

The advent of 5G will require a new wave of infrastructure investment. While forecasts suggest that network costs could double as investors upgrade 4G and manage the evolution to 5G,⁷⁶ it is likely that MNOs will largely absorb and manage the additional required capital investment.

A major contributor to this cost is the need for more physical infrastructure than 3G and 4G. 5G requires

higher densities of towers and cells to address higher traffic loads and enable the use of higher radio frequencies. This will necessitate a shift towards using smaller cells in closer proximity to one another, and the deployment of a deep-fibre network. This creates challenges in retrofitting cities and in creating sufficient densities in more remote areas. However, analysis suggests that upgrading mobile tower sites, delivering small cells in high-density areas and moving towards nationwide rollout could be achieved within existing capital expenditure envelopes if carefully staged over the next five to seven years.⁷⁷

Though MNOs have some existing powers relating to telecommunications infrastructure deployment and installation,⁷⁸ there has been recent public opposition to the rollout of more cells without community consultation, particularly in cities.⁷⁹ Concerns around security and health are most commonly cited oppositions to these small cells, though experts have maintained that these concerns are no greater than those presented by larger telecommunications towers that already exist.⁸⁰

Currently, under the *Telecommunications Act 1997* (Commonwealth), necessary equipment can be installed on public infrastructure such as light poles without the need to gain council approval.⁸¹ The denser 5G rollout may increase operator focus on consultation with the community around use of these powers. The ACCC expects MNOs to be interested in sharing 5G cell infrastructure, particularly in fast-growing cities.⁸² The use of other street objects and furniture, such as public transport signage and structures may help to reduce both the capital costs of rollout and allow smaller players to still maintain a presence in the market.

In rural and remote areas, it is likely that existing challenges faced with 3G and 4G coverage will be exacerbated with the rollout of 5G. This is because 5G services require higher densities of cells, and therefore higher costs to network owners. It is likely that rollouts will prioritise more densely populated areas, where the number of users is higher and the fixed costs can be met by a higher number of users.

157. Challenge

5G networks will require substantial new infrastructure, creating both cost, planning and security challenges. In cities, this means retrofitting new cells into existing streetscapes, and in rural and remote areas, this means creating adequate densities and improving coverage beyond that of 3G and 4G. Adequately balancing shared and competing tower and cell sites will affect the scale of investment, and ultimate costs users pay.

When this
will impact:

0-5

5-10

10-15

15+

Where this
will impact:



Finite mobile spectrum allocation has implications for users

The availability of spectrum is key to the success of mobile operators. Spectrum is the finite radiofrequency that underpins mobile telecommunications. Different parts of the radio spectrum have different attributes, making them more or less suitable for different uses, but also creating competition between different uses. Sharing spectrum can create interference, requiring the creation of a form of property rights for different uses, such as defence, emergency services, broadcasting and mobile applications.

Access to spectrum is a barrier to entry into wireless telecommunications markets. Allocation of spectrum by the ACMA, generally by auction, aims to balance the different needs of these stakeholders, while providing opportunity for MNOs to acquire access to spectrum that meets their users' needs and geographical footprints. In turn, access for mobile operators to spectrum range impacts competition in the mobile market. The large telecommunications providers (including Telstra, Optus and Vodafone, as well as nbn) are the major holders of commercial spectrum, both in urban and regional areas.

Recent auctions will be significant to the 5G rollout. Higher frequency spectrum is more suited for denser coverage areas with larger data consumption and will likely be used in cities in conjunction with the rise of small cell networks. Lower frequency spectrum is expected to be used in regional, rural and remote areas.

There are challenges in Australia's current approach to spectrum allocation, including harmonisation of band according to the global ecosystem, making more available by spectrum transfer (for example, satellite band), clearing spectrum faster for use, and enabling secondary market operation for operators to trade and swap spectrum to achieve optimum network performance.

Wide-area narrow band networks are being delivered across many parts of regional Australia, supporting low bandwidth uses, such as simple IoT for water monitoring in agriculture.

These networks are also used for emergency services, however their future as a fit-for-purpose solution could be compromised by issues of reliability and capacity. Some state jurisdictions, New South Wales and Victoria, have made some progress upgrading to more contemporary solutions, such as an Long-Term Evolution standard that offers mission-critical press-to-talk over a dedicated network. However, the provision of a nationally consistent, integrated solution is lacking thereby potentially impacting cooperation amongst jurisdictions during emergencies.

158. Challenge

Government needs to balance different demands, including from mobile service providers, to deliver efficient and competitive allocation of radiofrequency spectrum. This will affect the quality and cost of mobile services for users.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



8.4 Maximising the benefits of nbn investment

At a glance

With the nbn rollout almost complete, we must look at how to harness its benefits. This section covers:

- Tensions between nbn user outcomes and the need to provide a return on the capital investment from taxpayers
- Technological changes during the rollout that have affected quality
- The need for comprehensive national coverage and associated funding challenges
- Possible privatisation once the nbn is fully operational and the impact on market structure.

There is an inherent tension between user outcomes and return on investment for the nbn

The government-owned nbn was announced in April 2009 as a replacement for Telstra's copper access network. The central aim was that every person and business in Australia, no matter where they were located, would have access to affordable, fast broadband.

It was structured off-budget and is required to eventually pay its way, including providing a return to the Australian Government, as owner. nbn provides wholesale services to commercial network operators, and other retail service providers.

The sole shareholder, the Australian Government, states the core objective for nbn as:

"....ensuring that all Australians have access to very fast broadband as soon as possible, at affordable prices, and at least cost to taxpayers. The Government expects the network will provide peak wholesale download data rates (and proportionate upload rates) of at least 25 megabits per second to all premises, and at least 50 megabits per second to 90 per cent of fixed line premises as soon as possible. nbn should ensure that its wholesale services enable retail service providers to supply services that meet the needs of end users".⁸³

In effect, the nbn needs to achieve four goals:

- Supply technology to support defined minimum speeds (quality of service)
- Provide access to all premises no matter where they are located (accessibility)
- Sell wholesale access to retailers at prices that enable end user take up (affordability)
- Make a return on taxpayer investment (profitability).⁸⁴

The first three of these goals are focused on direct user outcomes, and over time may compete with the fourth goal, to make a return on the taxpayer capital investment.

For example, with consumer resistance to paying more for telecommunications services, there is pressure on nbn to reduce its wholesale prices. nbn implemented some changes to its wholesale prices in 2018, and there is evidence that this has increased take up, and improved speeds.⁸⁵ To the extent wholesale price reductions are passed on to consumers, this should increase retail take-up of nbn services at higher speeds. To the extent that wholesale prices are too high, this will reduce nbn take up, subdue the economic benefits of the infrastructure network, and encourage network duplication from the private sector.

Including the proposed Regional Broadband Scheme, nbn has forecast it will achieve an internal rate of return of 3.2% from:

- Steeply rising average revenue per user
- Users opting for higher speed tiers and downloading more data
- Limited market share loss to competing fixed and mobile networks.⁸⁶

However, there are concerns around the realisation of these assumptions given users' apparent unwillingness to pay more for additional services, challenges in achieving fast speeds across all technologies, and the imminent rollout of competing 5G fixed wireless and mobile networks.

nbn has been structured as an off-budget entity, meaning that there is an expectation that shareholder equity will be repaid, with a return, from its growing operations. There are early budget impacts from the government's cost of borrowing to make equity injections, and it has contingent liabilities noted in the budget. However, the ultimate outcome for taxpayers and the budget may not be known until the nbn is valued by the private sector in a sale process, including if prior write-downs were to occur.⁸⁷

The ACCC has expressed a concern that the nbn may not meet its financial targets. It has raised the possibility of taxpayer price relief via a range of means such as debt payment concessions or direct budget funding of non-commercial services, to better promote the efficient use of the network and the long-term interests of end users.⁸⁸

159. Challenge

There is an inherent tension between the nbn's strategic goals, requiring potential trade-offs between achieving user outcomes and delivering a return on the capital investment made by taxpayers. If all goals cannot be achieved, the ability for Australians to access affordable and high-quality nbn services may be negatively affected.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



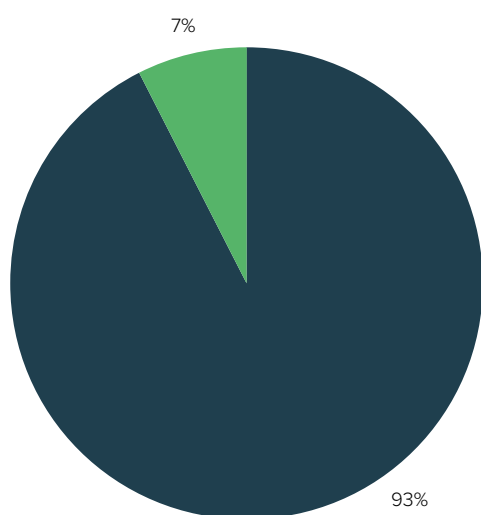
Changes to nbn technology will affect service quality

The nbn was primarily designed for residential and small business users. The original (2010) plan was for fixed line Fibre to the Premises (FTTP) for the approximately 93% of users in readily-accessible locations in our fast-growing cities, regional centres and towns. The remaining 7% of the population would receive fixed wireless (fringes of our cities and towns, and close-by rural hinterland) and satellite (rural communities and remote areas, and other hard to access locations).

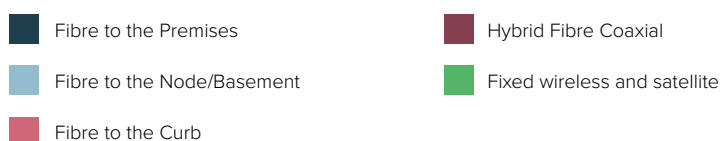
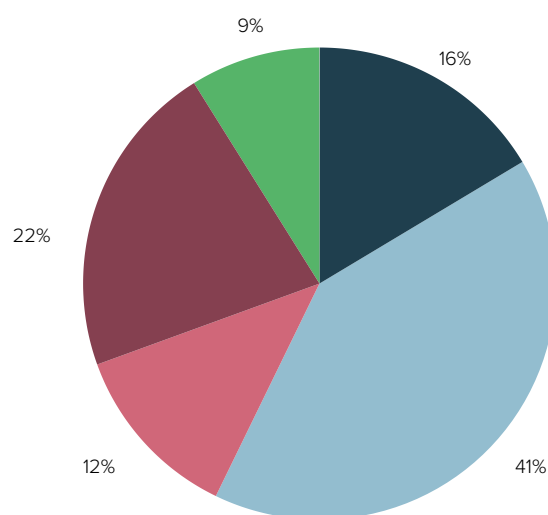
The FTTP focus has moved to what is now called a multi-technology mix. This different mix has altered projected infrastructure costs. For example, the need for upgrades to Hybrid Fibre Coaxial (HFC) connections under the current plan drives up capital costs and operating expenses. Figure 7 shows the different nbn technology mixes for the two approaches based on end of rollout forecasts for premises that are passed and connected (original plan) and ready to connect (current plan).

Figure 7: The nbn technology mix has changed since 2010

2010 Plan – at June 2021



Current Plan – at June 2020



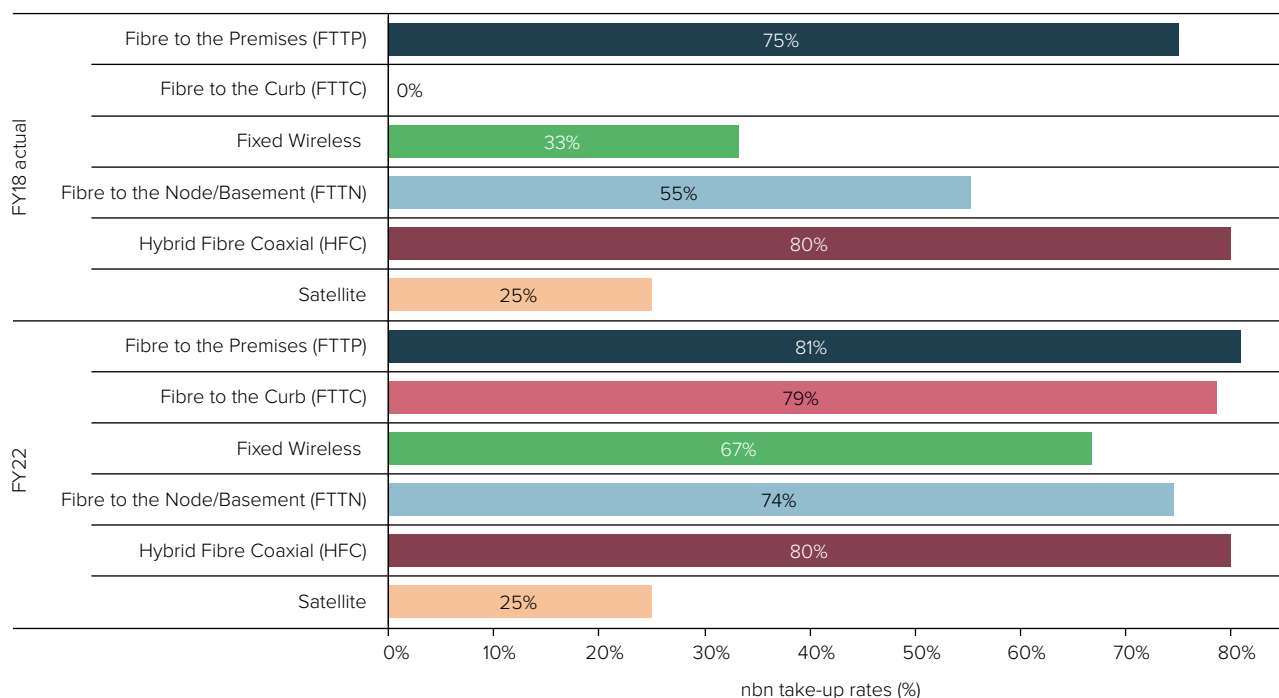
Source: nbn (2010, 2018)⁸⁹

There are inherent differences in performances depending on the type of technology used to deliver underlying broadband services. Each type (for example, Fibre to the Node (FTTN), Fibre to the Curb (FTTC), Fixed Wireless, and Satellite) has different speed capability, equipment and installation requirements, and power outage backup capacity.⁹⁰ While there is potential scope to increase data throughput of fibre and short copper connections, there are wireless spectrum-related limits to fixed wireless services and transponder capacity limits and inherent time delay issues for satellite services.

A range of nbn process and performance issues have arisen as rollout has proceeded and users have migrated to the network. Some issues have been or are in the process of being addressed, such as copper-nbn migration processes, disparities between claimed and actual speed performance,⁹¹ fixed wireless throughput bottlenecks at peak use times, and satellite service data limits.

The nbn short-term forecast is for underutilisation of satellite capacity by premises served by that technology, with the other technologies forecast at 75% or higher take up rates (Figure 8). Actual take up will be impacted by pricing strategy, and the relative value of alternative offerings.

Figure 8: nbn take-up rates by technology are expected to vary, with satellite the lowest



Source: nbn (2018)⁹²

The capital costs of the different technologies vary. Table 2 shows the estimates prepared by nbn of capital cost per premises for most of its technologies for the completed rollout.

As the rollout progresses, decisions are being made about nbn's technology boundaries and upgrade paths – this includes options to:

- Incrementally push out FTTP to more homes and businesses
- Expanding other options for fixed wireless upgrades, such as migration to 5G
- Expanding the amount of fibre within the HFC network
- Extending fixed wireless into satellite areas where this can be done without serious cost escalation.

In particular, there is potential for fixed mobile substitution through 5G fixed wireless access, providing broadband speeds and user experience equivalent to nbn for some segments of the market, particularly dwellings with Service Class 0 nbn status (premises that are within a Ready for Service fibre area, but require further work prior to activation, such as additional cabling).⁹³ The potential for fixed mobile substitution is especially high for those technologies, such as FTTN and FTTC, where achievable maximum speeds are variable and dependent on copper quality and length. MNOs are also at an advantage in this situation, compared to the nbn, because they are generally also fixed line providers and have more information regarding the characteristics of end users and so can tailor fixed wireless products.

Table 2: Capital costs per premises and speeds vary for each nbn technology

Technology	\$ per premises	Maximum current download speed (megabytes per second)
FTTP in existing buildings	4,400	1,000
FTTP in new buildings	2,100	1,000
FTTN/B	2,300	100
FTTC	3,000	100
HFC	2,500	100
Fixed Wireless	4,300	50
Satellite	N/A	25

Source: nbn (2018)⁹⁴

160. Challenge

The technology mix for the nbn has diversified, meaning different users will receive different types of connections. This change will deliver varied outcomes for users, and some may shoulder higher costs or receive lower-quality services.

When this
will impact:

0-5

5-10

10-15

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Where this
will impact:



Extending the nbn opportunity to all corners of Australia is a challenge

Uniform national pricing and competition in our fast-growing cities and our regional centres means nbn faces funding challenges. The per-user cost of telecommunications networks rises as population density falls. Due to uniform national pricing, this means that serving many regional and remote users will incur a net cost. While a purely commercial operator would stop pushing out the network at some point, the nbn is required to be built beyond that point into 'sub-commercial' locations.

A proposed Regional Broadband Scheme would levy a surcharge of approximately \$7 per service per month on all high-speed fixed line broadband providers (including nbn itself) to cover the cost of the non-commercial services.⁹⁵ The levy would not extend to fixed wireless and mobile services. In this sense, fixed line broadband users would be paying for all Australians to have minimum 25 megabits per second (Mbps) broadband, wherever their premises are located.

Looking forward, risks for the nbn include competition from ongoing fixed line services and 5G fixed wireless substitution. There is also the possibility of competition in remote locations from emerging low Earth orbit satellite technologies and other satellite technologies.⁹⁶ However, this is also an opportunity for the nbn to leverage these technologies to deliver better services in its existing fixed wireless and satellite coverage areas. The 2018 Regional Telecommunications Review has noted that about 70% of premises outside urban areas will have a fixed line broadband service by 2020.⁹⁷ However extreme remoteness makes connectivity for the remaining 30% harder as populations get sparser.

nbn's use of fixed wireless and satellite technologies limits the choice of available broadband speeds and download quotas, particularly for remote areas. However, these services are often the only option for regional Australian consumers and businesses. Although nbn is launching business-grade nbn services, these do not currently extend to nbn's fixed wireless and satellite access technologies. nbn is planning to deliver a business-grade satellite service in 2019.⁹⁸



161. Opportunity

Private market broadband and mobile operators are providing competitive services in commercial locations to fill nbn gaps. Leveraging competition can provide greater choice for users, supporting affordable and high quality services.

When this will impact:

0-5

5-10

10-15

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Where this will impact:



Structuring the nbn for the future will need to balance value for shareholders and users

The history of the nbn has involved technology and strategic change, and an often charged political debate about the quality and cost of services, and how to balance the size of the taxpayer investment with the expected benefits.

The future of the nbn, as indicated in its legislation, could see it privatised after it is declared 'built and fully operational' and subject to the Productivity Commission and the Parliament having assessed sale structure options.⁹⁹ This issue is expected to emerge from 2020 as the rollout is completed.

This raises questions as to whether or not the network will be sold, and if so, how the assets would be sold and therefore how the market will be structured. This means considering how to balance the need to deliver value for shareholders, through restructuring and sale, while still achieving the user outcomes for the nbn and delivering value into the future for Australians as the population continues to grow, and the importance of digital connectivity increases. These choices will affect the quality, access and cost outcomes for users, particularly for vulnerable groups such as remote communities and small businesses.

162. Challenge

A proposed eventual sale of the nbn to the private sector raises challenges in striking the right balance between realising its value for shareholders and achieving long-term goals for users.

Decisions about restructuring and sale can affect both short- and long-term service delivery and outcomes for users.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



8.5 Social inclusion and affordability for telecommunications services

At a glance

Australians are generally happy with their telecommunications service quality. As these services become more essential to modern society, governments are investing significantly to fill gaps and support growth.

But not all Australians have the same access. This section looks at gaps in service quality for particular groups of Australians. We will need community service obligations (CSOs) to address these inequalities.

Consumers rate services as costly, but still support more investment in these services. The last decade has seen great improvements, with service plans offering more data for less money.

This section also identifies a disproportionately large cost burden on lower-income households, and the tension between businesses' rising demands and their resistance to paying more. It looks at how we can enhance consumer choice and experience to strengthen the sector.

Telecommunications is now essential to participating in society

While telecommunications has always been essential for communication between people, the growth and pervasiveness of digital technology and connectivity in Australia today means that telecommunication networks play a critical role in how our society operates.

In 2018, ACMA noted that Australians are consuming more data and content than ever before, with 89% of Australian adults accessing the internet and 34.8 million mobile services in operation.¹⁰⁰

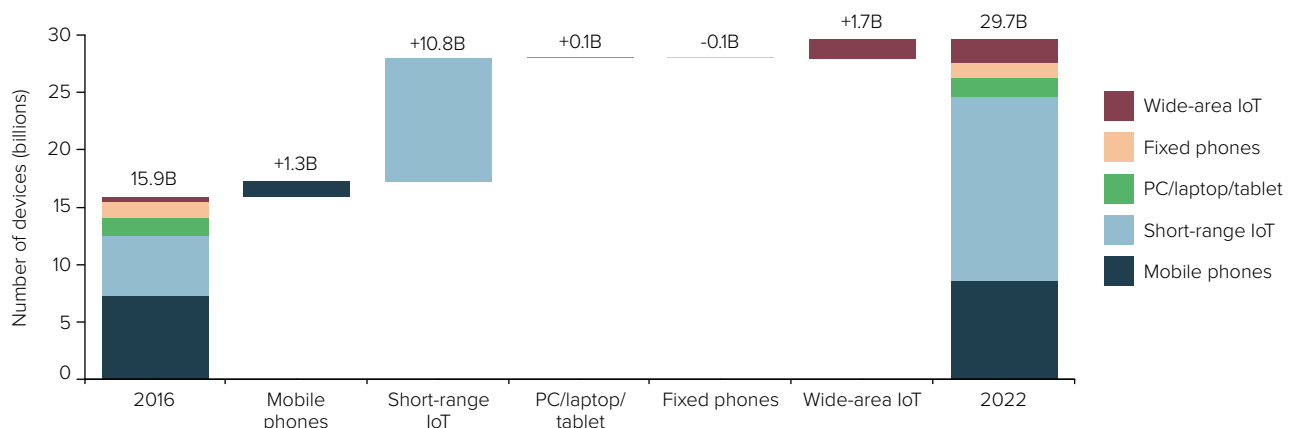
Participation in online commerce is mostly undertaken by middle-aged Australians, with lower rates for younger adults likely reflecting lower disposable income. Older people also have low rates of online commerce use due to less familiarity with the online world. In all groups, participation is increasing.¹⁰¹

In coming years, Australians' dependence on telecommunications infrastructure will rise further as:

- Businesses move more of their services and data into the cloud.
- Governments move online. The Australian Government is seeking to migrate all government service delivery to be digital by 2025.¹⁰² As many users of government services are among the least digitally included, there is a need to facilitate inclusion as part of the transformation.
- Consumers use smart devices and technology to enhance a range of aspects of daily life – from cashless payments on smartphones and watches, to tracking public transport services in real time.
- The use of IoT devices increases, connecting people and machines. This enables organisations to redefine their industry value chains, and helps people to better manage day-to-day household activities.

IoT devices and connections are expected to contribute almost 20% to the global growth in data traffic between 2016 and 2022.¹⁰³ As Figure 9 shows, forecasts suggest there will be almost 30 billion connected devices in the world by 2022, of which around 18 billion will be related to IoT.¹⁰⁴

Figure 9: Actual and forecast connected devices are growing quickly worldwide



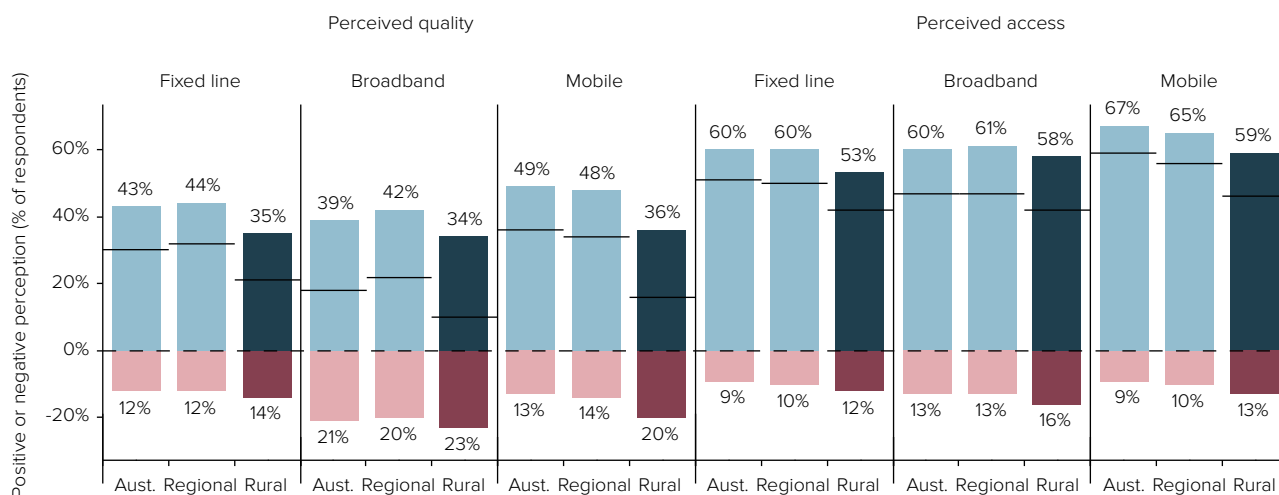
Source: Ericsson (2018)¹⁰⁵

Australians are generally happy with the quality of telecommunications services

The vast majority of Australians (greater than 75%) view telecommunications services as either average or good, with the quality of mobile networks and services the best at 85%.¹⁰⁶ Less than 16% of people believe that the quality of telecommunications is worse now than it was five years ago, and is likely to be worse five years from now.¹⁰⁷ More than 60% of Australians feel all types of telecommunications infrastructure is accessible, with mobile slightly more accessible than broadband and fixed line.¹⁰⁸ While consumers expect access to traditional fixed line services to stay the same, there is a firm expectation that accessibility for both broadband and mobile telecommunications will improve over the next five years.¹⁰⁹

Geographically, sentiments about telecommunications services are close to the national average in regional areas, but rural and remote communities are least positive about quality and access (Figure 10). While those living in rural and remote areas overall rate telecommunications as 'good' more than they do 'poor', people in these areas are more likely to have concerns about the quality of mobile (net 16% positive compared with 36% nationally) and fixed broadband services (net 10% compared with 18% nationally).¹¹⁰ This likely reflects changes in technology to fixed wireless, satellite and mobile technology beyond the regional fringe, and the associated speed, coverage and reliability issues as populations become sparser.

Figure 10: Consumers are more positive about access to telecommunications services than the quality of services



Note: The value at the top shows the percentage of survey respondents who had a positive perception, and the value at the bottom shows the percentage of survey respondents who had a negative perception. The black line shows the difference between the two values.

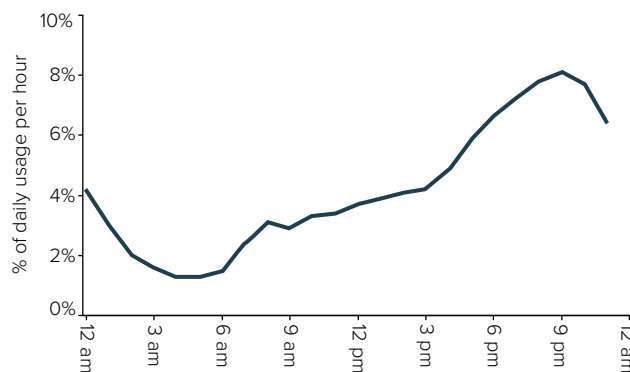
Source: JWS Research (2018)¹¹¹

Not all Australians have the same quality of service

Like most infrastructure systems, distances and congestion present challenges to networks as populations become either sparser or denser.

In our fast-growing cities, and in regional areas served by wireless broadband services, network crowding effects can occur across the network at peak times caused by bandwidth congestion as many people access data at the same time. BCAR estimates current peak broadband usage between 8pm and 10pm (Figure 11).

Figure 11: Broadband usage peaks in the evening, creating potential congestion



Source: Bureau of Communication and Arts Research (2018)¹¹²

There are also differences in allowable usage, which are driven by the type of infrastructure. For example, while some fixed nbn plans allow for unlimited downloads (subject to nbn’s fair use policy),¹¹³ nbn’s Satellite Sky Muster service typically has usage limitations due to the capacity constraints of the technology, which can in turn limits remote users’ access to the internet compared with those in cities.

To better understand actual broadband performance relative to the broadband plan, the Australian Government provided funding to the ACCC to implement an independent nbn performance monitoring and reporting program. The third ACCC Measuring Broadband Australia report showed that fixed line broadband speeds did not slow significantly in the busy hours (7-11pm), with average speeds across all busy hours reducing by just 1% compared with the average.¹¹⁴

The report also found that the differences between urban and regional fixed line services was not significant, with those in urban areas receiving 84.8% of maximum speeds on average compared with 83% of speeds in regional areas.¹¹⁵ Significantly, the ACCC does not measure fixed wireless or satellite speeds, which tend to occur in regional areas, and which

would reduce the overall average regional speed performance.

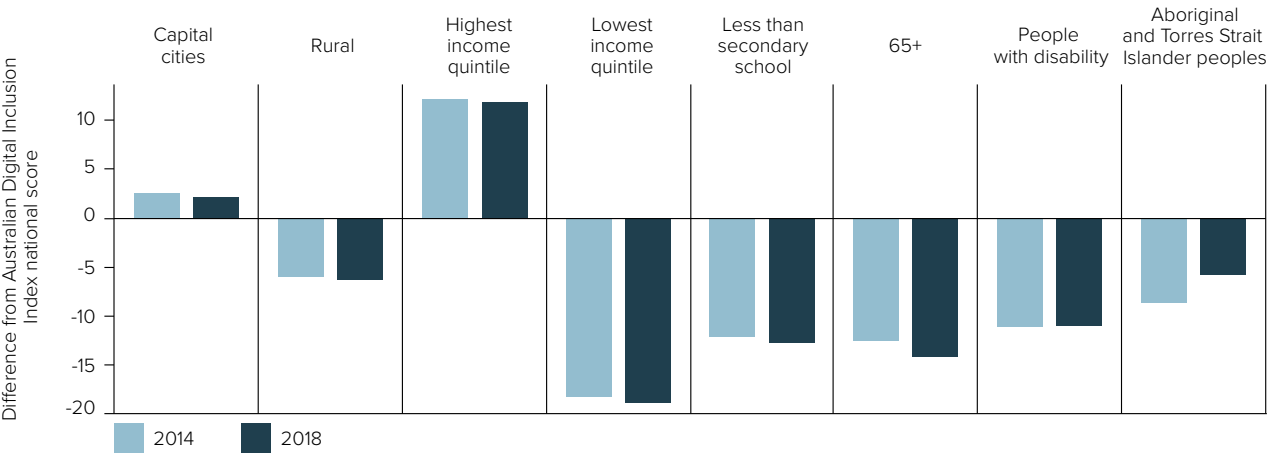
The ADII also showed differences between rural and urban areas.¹¹⁶ As Figure 12 shows, digital inclusion is low outside of fast-growing cities, particularly in rural areas, with limited improvement between 2014 and 2018.

While the 2018 ADII found that overall digital inclusion is improving over time, it also highlighted a substantial digital divide between certain segments of Australian society.¹¹⁷ Nationally, the groups that lag the Australian score in 2018 by over ten points include:

- The lowest 20% of households by income
- People who did not complete secondary school
- Those aged over 65
- People with disability.

The 2018 ADII also shows that Aboriginal and Torres Strait Islander peoples score 5.8 points below the national score, despite improvements since 2014. They also spend a greater proportion of their household income on internet connectivity while receiving less data for each dollar of expenditure.¹¹⁸

Figure 12: Digital inclusion is lower for those experiencing disadvantage and in rural areas



Note: Positive values represent digital inclusion higher than the national score, while negative values represent digital inclusion lower than the national score.

Source: Thomas et al. (2018)¹¹⁹

Ali Curung

The ADII includes a special survey of the remote Aboriginal community of Ali Curung, located 300 kilometres north of Alice Springs (112 individuals of a population of about 500 surveyed). The survey showed that this community uses the internet more than the Australian average to undertake activities such as online shopping, accessing government services, and accessing news.

However, the access index was much lower than the community overall due to the unreliability of mobile connectivity. Very few have a fixed broadband connection and the better objective value it provides users.

The higher absolute cost of a gigabyte of data (and smaller data allowances) on a mobile network compared with fixed broadband meant that affordability was very poor.¹²⁰



163. Challenge

The quality of telecommunications services varies for different groups across Australia, with digital inclusion lagging for low-income households, people who did not complete secondary school, those aged over 65 and people with disability. Without action, these people will be increasingly excluded from an increasingly digital world, exacerbating disadvantage.

When this
will impact:



Where this
will impact:



Enhancing consumer choice and experience

A competitive market helps drive the efficient use of existing assets, well-considered new investment, and greater choice for users. With market constraints on the ability to raise revenue for basic services, profits for telecommunications service providers are generally maximised through either cost efficiencies or product differentiation.

Despite the fact that Australia has a large degree of market consolidation in terms of operator market shares (with Telstra holding 51%), there is evidence of increasing competitive intensity for both mobile and fixed services. This reflects price and non-price competition by telecommunications providers in both fixed and mobile services. Providers are responding to strong consumer demand for communications services by providing greater choice and products at a range of price points.

The market for broadband plans has been relatively dynamic, with service providers constantly introducing new plans and removing or altering existing plans. Between 2013–14 and 2016–17, on average, less than half (43%) of the plans that were available in a given year were also available in the previous year.¹²¹ This suggests that characteristics of plans are currently changing considerably.

Analysis of mobile phone plans suggests that, with other characteristics including price unchanged, data quotas improved by 41% per year on average between 2014 and 2017.¹²²

In November 2017, the Australian Government announced the introduction of a consumer data right in Australia.¹²³ The consumer data right will improve consumers' ability to compare and switch between products and services. It will also encourage competition between service providers, leading not only to better prices for customers but also more innovative products and services.

The government has determined that the consumer data right will first apply to the banking sector, under a framework that will be known as Open Banking. The energy and telecommunications sectors are expected to follow banking. This should reduce the costs of switching and potentially spur innovation by service providers.

Reworking community service obligations in telecommunications

CSOs in telecommunications are likely to be required into the future as the challenges of digital inclusion remain, and digital connectivity becomes more central to people's lives.

CSO research commissioned by Infrastructure Australia has identified 18 defined CSOs in place across the telecommunications sector, at an estimated annual cost of \$1.8 billion.¹²⁴ Most of these costs are from CSOs put in place by the Australian Government.

The key findings of Infrastructure Australia's CSO research include:

- 62% of costs are for the provision of services above a commercial level or at below cost (primarily the nbn CSO)
- 35% of costs are for discounts, concessions and rebates (for example, the pension telephone allowance)
- Most of these CSOs were not provided in competitive markets, but generally formed parts of larger services (for example, as part of the nbn rollout)
- Over 80% of these costs were likely to remain stable into the future (not increase or decrease substantially over time)
- Only 44% of the telecommunications CSOs were found to be transparent in terms of their policy intent and target group, and reporting of costs and historical cost data.¹²⁵

The current Telecommunications Universal Service Obligation (TUSO) requires the provision of standard telephone services or payphones on request to every premises in the country, within defined timeframes. Telstra has the responsibility to deliver the TUSO and receives \$230 million per annum to provide fixed telephone services and \$40 million per annum for payphones. The Australian Government contributes \$100 million per annum, and industry contributes the remainder with Telstra contributing the most of any carrier.¹²⁶ This arrangement is currently in place until 2032.

In December 2017, the Australian Government changed the TUSO to acknowledge that the telecommunications market was now dominated by broadband and mobile technologies.¹²⁷ In December 2018, the Australian Government announced details of its new Universal Service Guarantee (USG), which will update the TUSO to give Australians guaranteed access to broadband as well as voice services – while ensuring current fixed telephone and payphone services are maintained in rural and remote areas.¹²⁸ The government has also stated that, while the USG will retain payphone services, there will be an examination of payphone locations given the uptake in mobile services.

164. Challenge

Telecommunications community service obligations lack transparency, competition and specificity, and are often technology prescriptive. Without action, both taxpayer and user outcomes will be further compromised, and CSOs will not service the locations and communities where need exists.

When this will impact:



Where this will impact:



Australians are using more data for less

While consumer demand for telecommunications services has grown rapidly, average affordability of these services has also improved in the last decade (Figure 13). This is in contrast with most other types of infrastructure, including water, energy and transport.

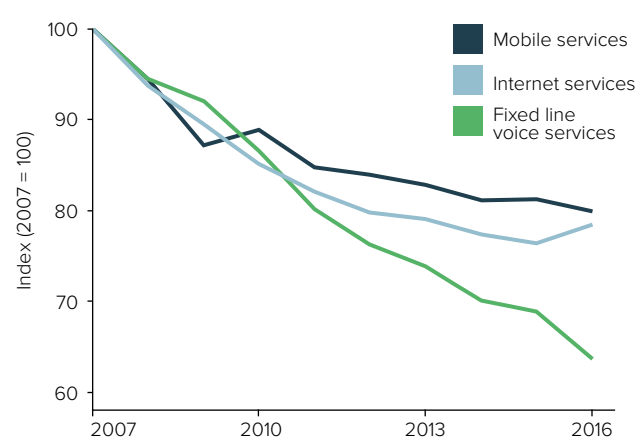
The rise of the smartphone, falling costs of data and an increase in adoption of applications such as Skype, WhatsApp and Facebook Messenger has meant that consumers have unprecedented choice when it comes to communications services. In the past 15 years, average household spending on communications services as a percentage of disposable income has generally fallen.

However, what is not captured in Figure 13 is that data limits for fixed and mobile services have substantially increased since 2012-13, as have product inclusions.¹²⁹ While it is not clear that this has resulted from direct customer demand, actual usage has strongly risen (Figure 14).

The average fixed broadband data consumption for a household is forecast to increase 340% from 95 GB a month in 2016 to 420 GB a month in 2026.¹³⁰ This will be driven by advances in technology such as high-definition content (4K/8K video), gaming, and augmented and virtual reality applications. It is estimated that the average speeds required to support this increased household consumption will

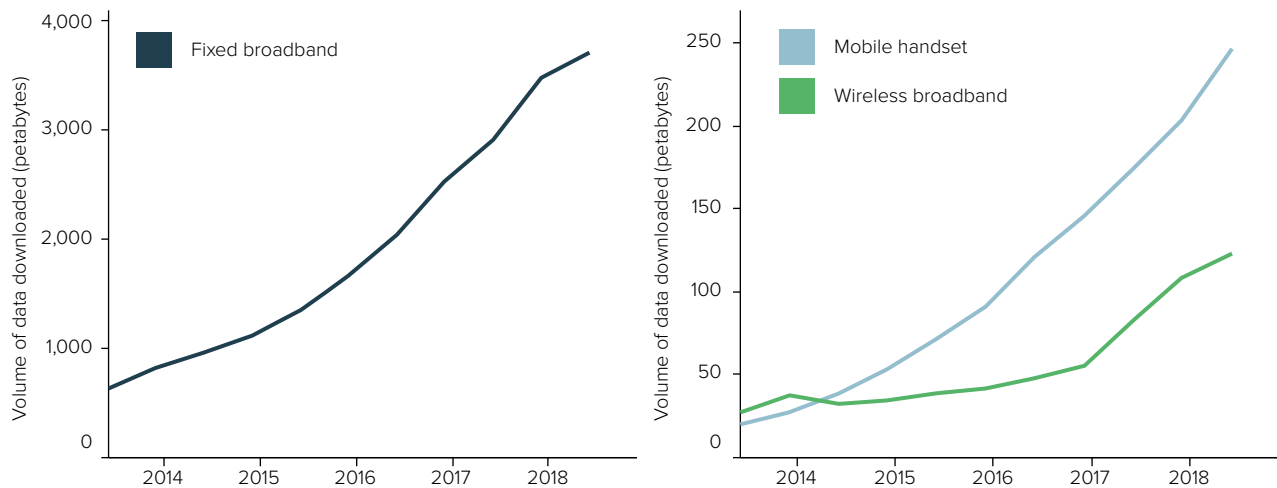
need to increase from between 11–20 Mbps in 2016 to between 20 and 49 Mbps in 2026, with only 2% of households expected to demand more than 49 Mbps in data speeds.¹³¹ The speed demand for businesses will vary by the nature of the business, and is likely to differ from household speed needs.

Figure 13: Telecommunications services have become cheaper over time



Note: The fixed line voice index is a measure of real changes in prices paid for fixed line voice services supplied using the public switched telephone network (PSTN) and voice over internet protocol (VoIP) technology. The mobile services index is a measure of real changes in prices paid for both prepaid and post-paid mobile services. The internet services index is a measure of real changes in prices paid for DSL, cable, wireless broadband and nbn internet services.

Source: Australian Competition and Consumer Commission (2017)¹³²

Figure 14: Data usage is growing, particularly for fixed broadband servicesSource: Australian Bureau of Statistics (2018)¹³³

However, consumers rate telecommunications as costly

Australians generally feel that they spend more on telecommunications services today than they did five years ago.¹³⁴

Figure 15 shows that consumers are more negative than positive about the affordability of fixed line, broadband and mobile services. Almost half of consumers rate broadband services as costly (44%, including 13% who rate them as 'very costly') and 31% rate them as affordable.¹³⁵ For mobile services, 39% of consumers rate services as costly, including 10% who rate them as 'very costly', and 36% rate their mobile services as affordable.¹³⁶ When compared to 27 categories of infrastructure costs, telecommunications ranks third, behind electricity and health and aged care, as the most costly.¹³⁷

However, when asked preferences for more or less investment in telecommunications infrastructure, the majority of consumers (greater than 66%) indicate they wanted more investment in both broadband and mobile telecommunications services.¹³⁸

Poorer households have a larger cost burden

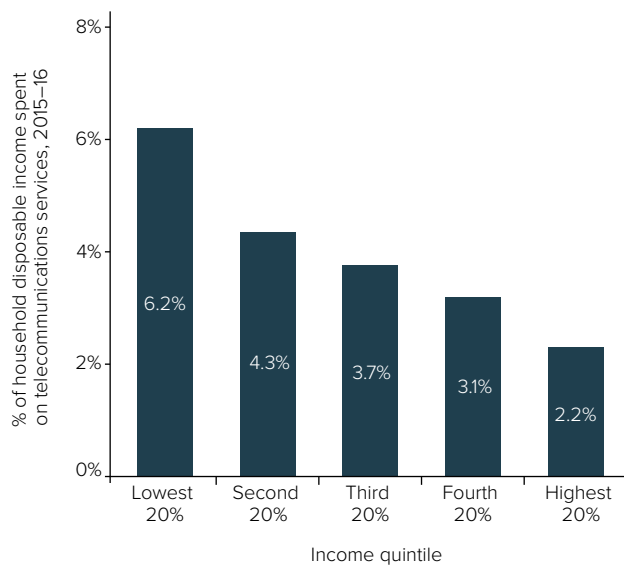
While spending on telecommunications services as a percentage of disposable income is trending downward for the average Australian household, more vulnerable groups (such as low-income households) have seen their spending increase as a proportion of their disposable income (Figure 16). In fact, households in the lowest quintile are estimated to spend almost three times the proportion of their income on telecommunications services and equipment (such as handheld devices, routers and other hardware) as the highest quintile.¹³⁹

Figure 15: More consumers are negative than positive about telecommunications affordability

Note: Net satisfaction refers to the percentage of respondents who had a positive perception of telecommunications affordability minus who had a negative perception of telecommunications affordability.

Source: JWS Research (2018)¹⁴⁰

Figure 16: Poorer households spend more of their income on telecommunications services than wealthier households



Source: Australian Communications Consumer Action Network (2017)¹⁴¹

For those on pre- and post-paid mobile plans, there are differing pressures for those on lower incomes, even with some eligibility for limited government support (Centrelink Telephone Allowance).¹⁴² Major network operators also have their own programs to assist users and communities to afford telecommunications services. On the one hand, pre-paid plans avoid cost spikes by restricting usage once a monthly limit is reached, constraining access but maintaining affordability. On the other hand, post-paid plans can have add-ins or billing cycles that make bill management harder.¹⁴³

In regional and remote Australia, connectivity is just as important an issue as affordability. To ensure continuous reliable coverage, many regional Australians are paying for multiple services to factor in redundancies for failing technology. Research from the Better Internet for Rural, Regional and Remote Australia volunteer group suggests that equipment costs in regional and remote Australia can be higher in order to maintain connectivity, with their 2016 survey showing that 72% of mobile broadband users had to purchase additional equipment (costing between \$1,000 and \$2,000) to access reliable mobile coverage.¹⁴⁴

165. Challenge

In fast-growing and smaller cities, telecommunications services are supported by substantial infrastructure that brings fast speeds and data allowances. Access to these services is unaffordable for some groups and can exacerbate socio-economic inequality.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



166. Challenge

In regional centres and rural and remote areas, telecommunications infrastructure often delivers costly services which provide poor connectivity, speeds and data allowances. This means people often require extra equipment, such as devices and other hardware, to access services, or can only access mobile data services. This creates impacts for both businesses and individuals, which can exacerbate spatial inequalities.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:





Business demand for telecommunications services is increasing, but there is resistance to paying more

Cloud computing, videoconferencing and the specific data needs of businesses and governments are driving demand for higher download and upload speeds.¹⁴⁵ It is estimated that 80% of Australian businesses already use cloud computing for software uses and 60% for data storage.¹⁴⁶

But there are costs for businesses in expanding their digital connectivity. This includes additional costs for data allowances, software, hardware and cybersecurity.

Research commissioned by Telstra indicates that, while over three-quarters of 550 surveyed businesses expect a productivity benefit from greater connectivity by 2030, they are split as to whether they are prepared to pay more for this service.¹⁴⁷

This suggests that many businesses are sensitive to pricing and that pricing may prove to be the biggest challenge for telecommunications providers to overcome – especially as they aim to increase 5G adoption amongst businesses. nbn wholesale pricing and business pricing packages are likely to have a major impact on business affordability.



167. Challenge

Businesses are increasingly demanding more from telecommunications services to compete in the digital economy, but increased downloads, speeds and storage come at a cost. Higher costs will reduce the ability for businesses to grow and compete domestically and internationally.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



8.6 Challenges and opportunities

Telecommunications enable productivity and innovation

152. Opportunity

Digital technologies are using telecommunications networks to enhance Australia's economic productivity. Embracing these new technologies can be a source of competitive advantage for Australia and can improve outcomes for users.

When this will impact:



Where this will impact:



153. Challenge

Australia's comparative performance for fixed broadband speeds is poor, and we lag well behind comparable nations. Failure to rapidly improve speeds could be a constraint on boosting productivity and liveability, and attracting businesses that require high levels of digital access.

When this will impact:



Where this will impact:



154. Challenge

Cybersecurity risks, such as data privacy and system resilience, are growing as more Australians use more interconnected digital services. Failure to manage these risks could affect user engagement with new services, and reduce the potential benefits of these services. Network efficiency could also suffer.

When this will impact:



Where this will impact:



The mobile coverage dilemma

155. Challenge

Prioritisation of mobile network upgrades in rural and remote areas creates gaps in crucial areas, such as on productive land and along transport corridors. Failure to deliver services to these areas affects community safety, liveability and productivity.

When this will impact:



Where this will impact:



156. Opportunity

5G technology presents an opportunity for Australia and we are well positioned to embrace it ahead of other nations. Delivering 5G networks will help to accelerate Australia's digital transformation, providing significant benefits to people, businesses and governments.

When this will impact:



Where this will impact:



157. Challenge

5G networks will require substantial new infrastructure, creating both cost, planning and security challenges. In cities, this means retrofitting new cells into existing streetscapes, and in rural and remote areas, this means creating adequate densities and improving coverage beyond that of 3G and 4G. Adequately balancing shared and competing tower and cell sites will affect the scale of investment, and ultimate costs users pay.

When this will impact:



Where this will impact:



158. Challenge

Government needs to balance different demands, including from mobile service providers, to deliver efficient and competitive allocation of radiofrequency spectrum. This will affect the quality and cost of mobile services for users.

When this will impact:



Where this will impact:



Maximising the benefits of nbn investment

159. Challenge

There is an inherent tension between the nbn's strategic goals, requiring potential trade-offs between achieving user outcomes and delivering a return on the capital investment made by taxpayers. If all goals cannot be achieved, the ability for Australians to access affordable and high-quality nbn services may be negatively affected.

When this will impact:



Where this will impact:



160. Challenge

The technology mix for the nbn has diversified, meaning different users will receive different types of connections. This change will deliver varied outcomes for users, and some may shoulder higher costs or receive lower-quality services.

When this will impact:



Where this will impact:



161. Opportunity

Private market broadband and mobile operators are providing competitive services in commercial locations to fill nbn gaps. Leveraging competition can provide greater choice for users, supporting affordable and high quality services.

When this will impact:



Where this will impact:



162. Challenge

A proposed eventual sale of the nbn to the private sector raises challenges in striking the right balance between realising its value for shareholders and achieving long-term goals for users. Decisions about restructuring and sale can affect both short- and long-term service delivery and outcomes for users.

When this will impact:



Where this will impact:



Social inclusion and affordability for telecommunications services

163. Challenge

The quality of telecommunications services varies for different groups across Australia, with digital inclusion lagging for low-income households, people who did not complete secondary school, those aged over 65 and people with disability. Without action, these people will be increasingly excluded from an increasingly digital world, exacerbating disadvantage.

When this will impact:



Where this will impact:



164. Challenge

Telecommunications community service obligations lack transparency, competition and specificity, and are often technology prescriptive. Without action, both taxpayer and user outcomes will be further compromised, and CSOs will not service the locations and communities where need exists.

When this will impact:



Where this will impact:



165. Challenge

In fast-growing and smaller cities, telecommunications services are supported by substantial infrastructure that brings fast speeds and data allowances. Access to these services is unaffordable for some groups and can exacerbate socio-economic inequality.

When this will impact:



Where this will impact:



166. Challenge

In regional centres and rural and remote areas, telecommunications infrastructure often delivers costly services which provide poor connectivity, speeds and data allowances. This means people often require extra equipment, such as devices and other hardware, to access services, or can only access mobile data services. This creates impacts for both businesses and individuals, which can exacerbate spatial inequalities.

When this will impact:



Where this will impact:



167. Challenge

Businesses are increasingly demanding more from telecommunications services to compete in the digital economy, but increased downloads, speeds and storage come at a cost. Higher costs will reduce the ability for businesses to grow and compete domestically and internationally.

When this will impact:



Where this will impact:



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Next steps	Water	Telecommunications	Energy	Social infrastructure	Transport	Industry	Users	Future trends	Introduction	Executive summary
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9

Water

Water supports almost every part of our lives, from the functional – clean, reliable drinking water and safe wastewater services – to the social – providing green spaces and clean waterways – and the environmental – sustaining natural life, enhancing biodiversity, and supporting natural habitats of flora and fauna. Access to clean water in nature is also integral to the Australian way of life and helps to draw tourists from around the world to our pristine beaches, harbours, reefs, rivers and other natural habitats.

Water can be expensive to store, transport, treat and manage. Infrastructure required to manage water is typically fixed and long-lived, raising the importance of getting investment decisions right for users, communities, utilities, investors and the economy.

Water infrastructure can be split into urban and productive components that provide essential services for people and industries:

- Urban water includes potable supply and wastewater services, as well as a range of integrated water-cycle components such as desalination, recycling and stormwater in cities, towns and remote communities. Depending on the region, bulk water services may be separate to or part of retail urban service providers.
- Productive water includes bulk water storage, delivery metering and control assets. Productive water markets also include the provision of licensing, allocation and trade of water from surface and groundwater sources, as well as entitlements for environmental and cultural purposes.

Beyond these services, many Australians – particularly in rural and remote areas – rely on small, localised or onsite systems. These assets include discrete rural water bores, reservoirs, pumping stations, septic tanks and other treatment and disposal systems for residential purposes, as well as a range of local on-farm dams, levees and other storages for productive users.







9.1 Introduction



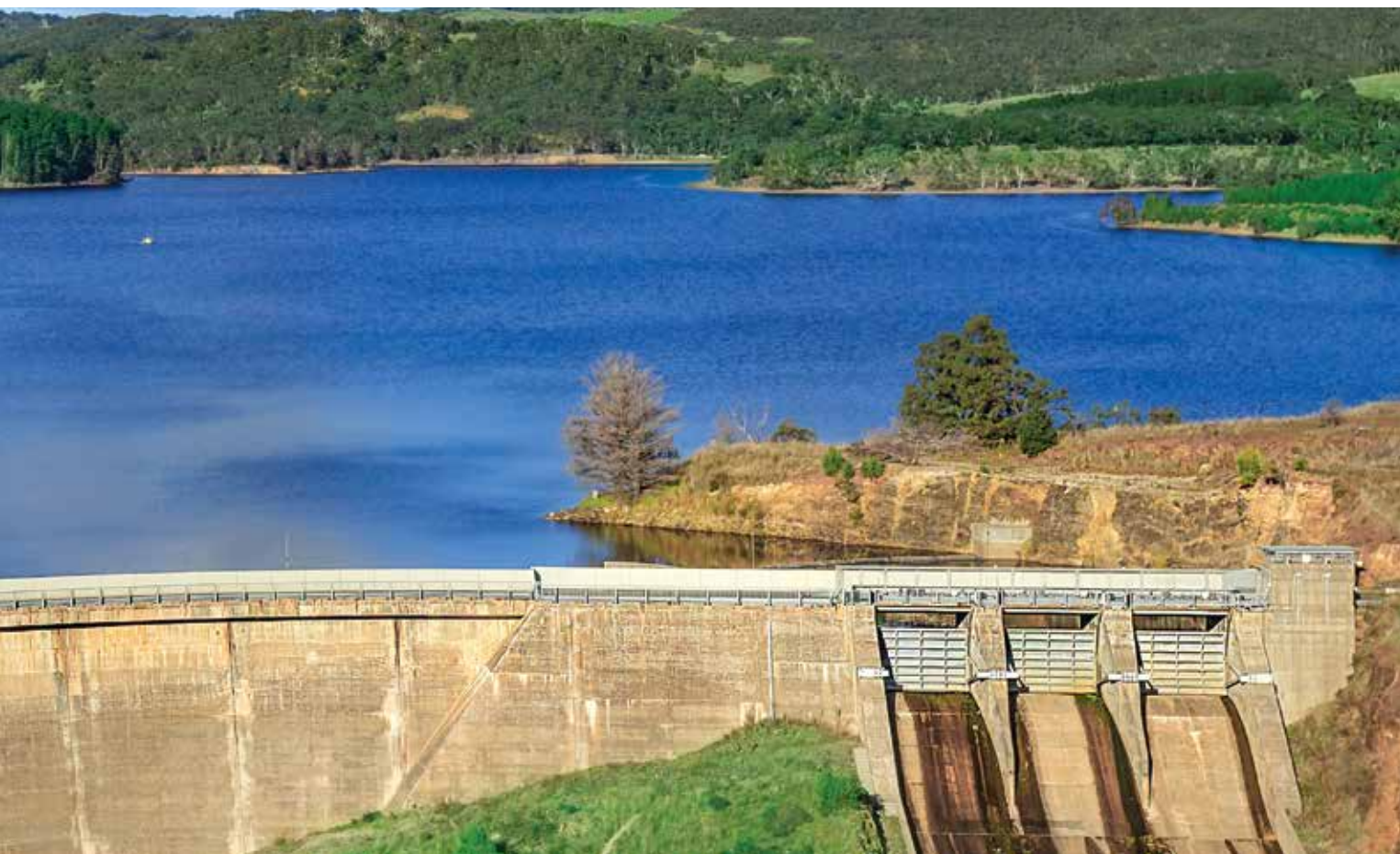
The state of the water sector

Australia's water sector has typically performed well in meeting the needs of businesses and households over many years across most of the country. For many users, safe, reliable and affordable water is largely taken for granted, as a result of these past successes. Many industries, including agriculture, mining and manufacturing, have used efficiently-provided, productive water to support growth and productivity, particularly in regional areas.

However, the sector faces unprecedented risks and challenges. Climate change, population growth, ageing assets, and competing interests will ramp up pressure for limited resources. Advances in technology, markets and planning can help to overcome these challenges, but many will require changes in laws and regulations to unlock benefits.

The true value of water is poorly understood by users and many in the sector. Unreliable and incomplete evidence undermines the effectiveness of decisions, and community confidence in water managers. Overcoming the challenges facing the water sector and preparing for the future will require a shift in planning and decision making to ensure the long-term interests of a range of stakeholders are protected.

Water services in some parts of the country do not meet an acceptable standard. Advances in urban water in metropolitan areas risk leaving large parts of the country behind. There are significant barriers and costs for delivering safe and reliable water and wastewater to all Australians. Without action, these barriers could drive further inequality, and undermine progress towards national targets and commitments.

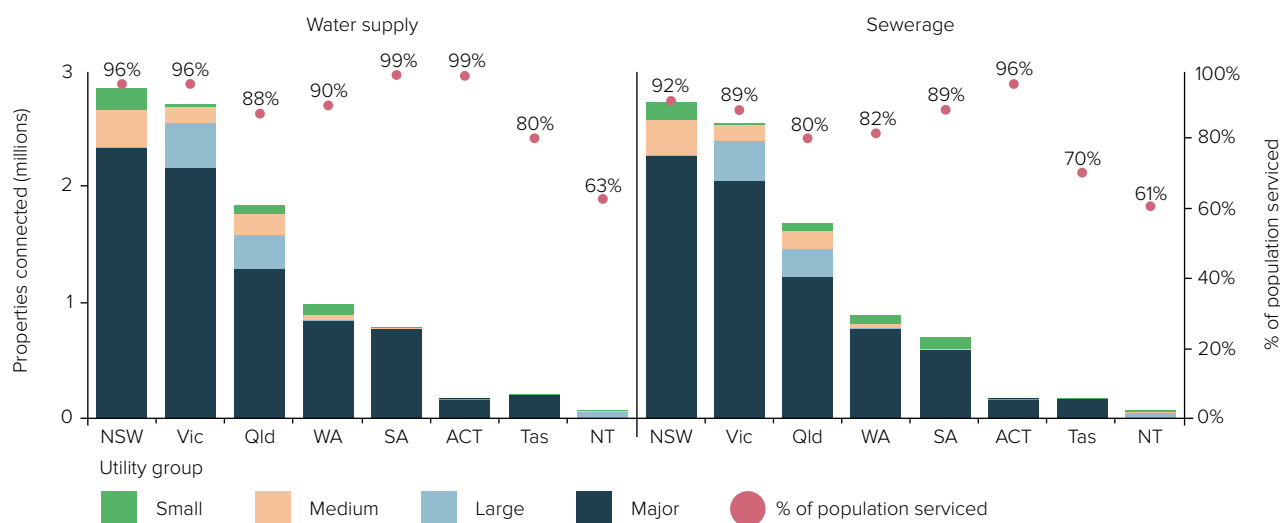


The scale of the water sector is immense

The Australian water sector provides essential services to almost all people and businesses. Across the Australian economy, users consumed around 16,500 gigalitres of water in 2016-17 – enough to fill Sydney Harbour 33 times.¹ Water and wastewater services are delivered by around 196 businesses and local governments in Australia's cities and towns. There are also a range of smaller licensees that provide local and specialised services, including in remote communities.² Figure 1 gives a national picture of water services across the country.

Australia's urban water sector generates annual revenue in excess of \$15 billion and directly accounts for 0.75% of Australia's GDP.³ Urban water costs are shared across the total water and wastewater supply chain, comprising bulk water supply (21% of total cost share), water treatment (11%), water transport (24%), wastewater transport (24%), wastewater treatment (16%) and retail (4%).⁴ The household sector contributes 51% of total costs for water supply,⁵ while consuming 12% of the water,⁶ in part due to the additional costs of treatment and supply for potable use.

Figure 1: A national picture of water services



Source: Bureau of Meteorology (2019), New South Wales Department of Primary Industries (2017) and Essential Services Commission of South Australia (2020)⁷

By contrast, industries spent \$4.9 billion on water supply in 2016-17, which represents around 46% of total costs,⁸ while consuming 88% of water.⁹ Of this, the agricultural sector consumes 62% of the total national volume (10,300 gigalitres, enough to fill four million Olympic swimming pools each year)¹⁰ while contributing 6% of total costs for water supplied.¹¹ Of this, 9.7 million megalitres were used to irrigate crops and pastures.¹² However, this water supports over \$15 billion in value from irrigated agriculture each year.¹³ By comparison, around 2,100 gigalitres are recovered by the Murray-Darling Basin Authority each year and retained in the system, to improve the health of the river system.¹⁴

The vast majority of urban water assets remain publicly owned. However, private participation in the urban water sector has grown considerably over recent years, with private operators providing services to utilities of all sizes. For example, Sydney Water outsources around 90% of capital expenditure and 70% of operating expenditure to private suppliers.¹⁵

The water sector has a strong record of meeting users' needs

Many Australians rarely think of where their drinking water comes from, or where their wastewater goes. Fewer still understand the water required to put food on their plates, or to create the many other goods and services that they rely on.

This is a product of the success of our water sector, which has provided high quality services to most users over many decades. We have been a leader in the development and application of environmental and health standards – such as the Australian Drinking Water Guidelines.¹⁶ This has been achieved in spite of difficult geographical and climatic conditions, and urban built environments that have grown in scale and evolved considerably over time.

This success has also been the product of past reforms, triggered by the 1994 COAG Reform Framework – as part of the broader National Competition Policy agenda – and the National Water Initiative in 2004. Developments in water markets, particularly the southern Murray-Darling Basin, have underpinned steady growth in the value of economic activity supported by water.

Recent events have undermined confidence in water management

Australians have come to expect a high quality of water services. Perhaps for this reason, issues that have emerged or taken on added significance since the last Audit have come as a shock to many people. These include concerns about running out of drinking water in some regional towns, fish deaths in parts of the Murray-Darling Basin, and rising bills to pay for expensive infrastructure upgrades. For many, this may be the first time they have considered risks to Australia's water services, or the potential impacts of poor water management on their personal or business needs.

These events are no reason to lose faith in the capacity of the water sector to provide high quality services, reliably and efficiently in future. However, they do provide a reminder to governments and service providers. These events also provide impetus for renewed efforts to progress important reforms to ensure Australians can continue to receive reliable services in the future, and know that water is being managed in a way that balances competing needs and mitigates risks efficiently.

Reports over recent years provide guidance on how to ensure water services continue to meet Australia's needs into the future. Notably, the Productivity Commission undertook inquiries into reform of the water resources sector,¹⁷ and a five-year assessment of the *Murray-Darling Basin Plan*.¹⁸ Infrastructure Australia also released a report that called for reform of the urban water sector to ensure the long-term interests of users are protected from mounting risks and rising costs over the coming years and decades.¹⁹



The sector faces unprecedented risks and challenges

As with other forms of infrastructure, the water sector has faced mounting challenges from factors such as population growth, climate change and changing user expectations.

However, of all the forms of infrastructure, the potential risks and costs of climate change are greatest in the water sector. The water sector relies heavily on rainfall to replenish storages, streams and groundwater, and on vibrant ecosystems to support a reliable water cycle. Higher temperatures can also increase the volume of water in storage lost through evapotranspiration. Extreme weather events such as floods, cyclones and bushfires, as well as rising sea levels and increased coastal inundation, can also damage assets or disrupt wastewater treatment processes. These bring heightened risks for the health of our waterways, management of wet weather flows and contaminants in residential areas.

Meeting growing demand is also a major challenge. The costs of augmenting water supply close to major cities present issues with managing water security efficiently. There is rising demand for Australia's agricultural products, increasing the call on water for production. While water markets can direct water to its most productive use, a further extended period of drought could put the viability of some of Australia's water-intensive agricultural products in doubt.

These risks are compounded by the age and condition of many water, wastewater and stormwater assets. Many are reaching the end of their lifecycle, and are approaching their full capacity or were designed and built many decades ago, for a nation of a different scale and distribution than it is today. This presents an opportunity to transform the way water and wastewater services are delivered – moving from a capture, use and dispose approach to an integrated water-cycle management where we use, recycle and reuse water resources.

The value of water and wastewater services is not well understood

While we all value water as a vital part of our daily lives, few understand its true value. In part, this is due to a lack of exposure to the full costs of the water we consume – both directly through our taps, and indirectly through our food and other products. Similarly, the value of wastewater services and the role existing systems play in safeguarding the environment are not well appreciated by users.

This lack of understanding of the value of water impacts user behaviours. Australians consume an average of 82,000 litres of freshwater per person each year.²⁰ A further 80 litres of water per connection every day on average are lost by utilities before it even reaches our homes. For small utilities, this figure is around 110 litres per day.²¹



Water markets help to attribute value to productive water, and direct it to higher-value uses. However, these transfers are not without their own issues. Moving water between uses and locations shifts economic activity, often also shifting jobs and opportunities for growth. Water moving out of some irrigation districts can leave stranded assets, or bring changing requirements for other forms of infrastructure, such as transport and telecommunications, to support changes in economic activity and supply chains.

Compounding this lack of understanding, much of the information on water we use is not transparent, reliable or expressed in terms that users can understand. Many governance and regulatory processes lack clear objectives focused on long-term user interests.²² In rural water markets, developments in allocation and trading has come at the expense of complexity and community understanding, leading to many stakeholders feeling excluded from decision making or upset with operators' and regulators' decisions.

Each jurisdiction has separate agencies responsible for the economic, environmental and health regulation of urban water and wastewater services. The independence and accountability of these agencies vary.²³ Lines of accountability between governments, regulators and service providers are often muddled – and in some cases all entities report to the same water minister. In some jurisdictions, ministerial interference in price setting has caused some community concern. These issues make it difficult to plan for the future, to provide users with confidence that decision making is robust, and to communicate long-term plans to users.

Water services in some parts of the country do not meet acceptable standards

Water services across the country are not available equitably, and the gap between users at each end of the spectrum is growing. Services in many cities are evolving and improving, propelled by strong revenue bases and access to new technologies that reduce costs for service providers and improve the customer experience.

It is a different story in many remote communities. In some of the most isolated parts of the country, including those with some of the most economically and socially disadvantaged populations, water services do not meet standards that urban residents would expect. Independent audits of compliance in remote communities are relatively infrequent, often limited in scope, and rarely publicly disclosed.

Many remote communities are home to a high proportion of Aboriginal and Torres Strait Islander people, meaning poor standards of water and wastewater services compound historical hardships and reinforce disadvantage. A lack of access to clean water and sanitation can worsen existing health issues and increase risks of disease and infection.

There is clear evidence that services in many of these remote communities do not meet United Nations' Sustainable Development Goal (SDG) 6: clean water and sanitation for all,²⁴ and work against the achievement of broader national objectives, including the Australian Government's Closing the Gap targets.

In this chapter

This chapter examines the key trends impacting the water sector across urban and productive markets, and in different parts of the country.

9.2 Changes facing urban water identifies a number of mounting challenges posing risks to service delivery, particularly population growth in our cities, the impacts of climate change and increasing concerns over the health of our waterways. In addition to these external factors, water, wastewater and stormwater assets across many parts of the country are ageing. Failure to address these challenges is likely to add to costs or compromise service quality.

9.3 Sustainable water for liveable cities explores how water is fundamental to liveability in our cities, and its importance will grow over coming years. However, density and changing expectations require a rethink of how water services are provided. Changing how we use water and exploring alternative water sources can help to meet our future needs.

9.4 Water and wastewater in regional and remote communities discusses how these services play a vital role in supporting regional and remote communities – including smaller towns, rural communities and remote areas – as vibrant, sustainable and attractive places to live. However, service providers in these areas face growing challenges, including rising costs and resilience risks. Critically, we cannot be sure that

services are meeting acceptable standards in remote communities, meaning Australia is not meeting UN Sustainable Development Goal 6.

9.5 Water oversight, regulation and decision making explains how the value of water is not well understood, and that this is leading to poor decision making. Evidence on water is incomplete, unreliable and does not adequately reflect outcomes that matter to users. Also, governance and decision making in the water sector are not meeting best practice and are not adequately preparing Australia for the future.

9.6 Balancing competing needs for water seeks to understand that while water reforms have brought some benefits, a fair and sustainable balance between competing needs for water has not been achieved in many parts of the country. A lack of transparency in water management and the complexity of water markets is undermining social licence and confidence in decision making. But there are opportunities to use water to unlock new economic activity. The southern Murray-Darling Basin water market has supported growth and productivity improvements in local industries, and water could help to unlock growth in other parts of the country.

Performance of the sector

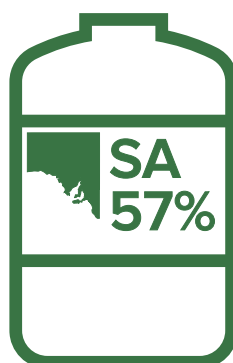
Cost



Brisbane: \$176
Perth: \$100

Almost 20% of households in Brisbane and Perth have a swimming pool, but filling a pool in Brisbane costs almost twice as much as in Perth ²⁵

Access



Proportion of households with water tanks ²⁶

Quality



Unknown

Number of Australians who are at risk of receiving water services that don't meet Australian Drinking Water Guidelines or UN Sustainable Development Goal 6

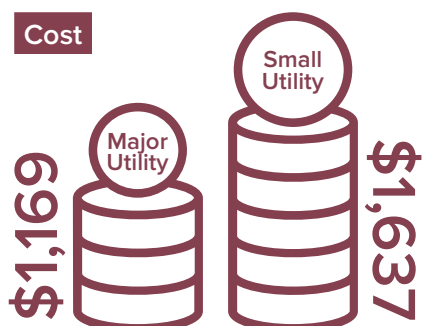
Quality



80 litres

of water lost by utilities per connection on average each day ²⁹

Cost



Average bills for small utilities are

40% higher

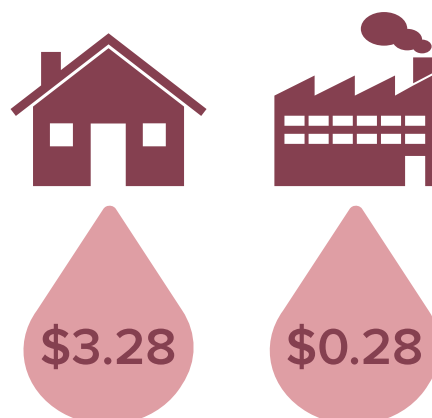
than for major providers ²⁷

Access



Each year
2,000GL
of water is being recovered for the environment in the
Murray Darling Basin ²⁸

Cost



Cost of water per kilolitre for households and industry ³¹

Access

Residents with access to mains water from a utility with over

10,000 connections ³⁰

NT 63%

ACT 99%

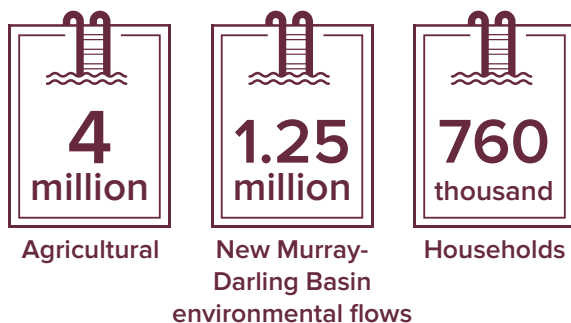
AUS 93%



Scale of the sector

Customer

Annual water consumption in Olympic swimming pools ³²



Asset



18% increase in **recycled water supplied** by major utilities over the past 4 years ³³

Industry

The water sector

contributes \$13 billion in value add, 0.97% of GDP ³⁴



\$13b

Asset



Unknown

The age and condition of urban water assets across the country

Customer



104% increase

in distributed water use by agriculture between 2008-09 and 2016-17 ³⁵

Industry

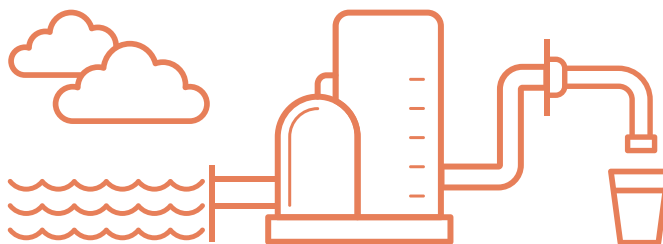
Typical cost shares in water and wastewater supply chain:

Bulk water supply **21%**
 Water treatment **11%**
 Water transport **24%**
 Wastewater transport **24%**
 Wastewater treatment **16%**
 Retail **4%** ³⁶

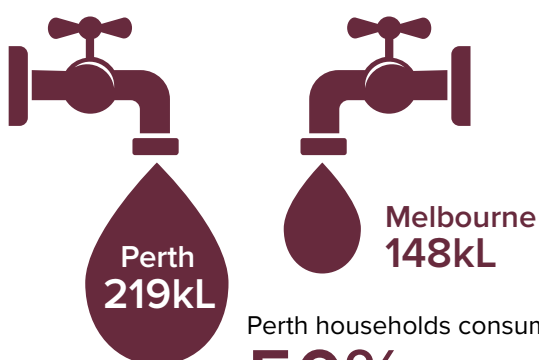


Asset

36% of Perth's water supply is from desalination ³⁷



Customer



Perth households consume

50% more

water than Melbourne households ³⁸

Industry



27,000

people employed in water supply, sewerage and drainage services, adding

\$18.9 billion to the economy ³⁹

9.2 Changes facing urban water

At a glance

This section outlines key challenges our water infrastructure will face in coming years:

- Climate change affects water supply patterns and threatens our assets.
- Population growth has consequences for our water security and infrastructure.
- Older assets need to be replaced and upgraded.

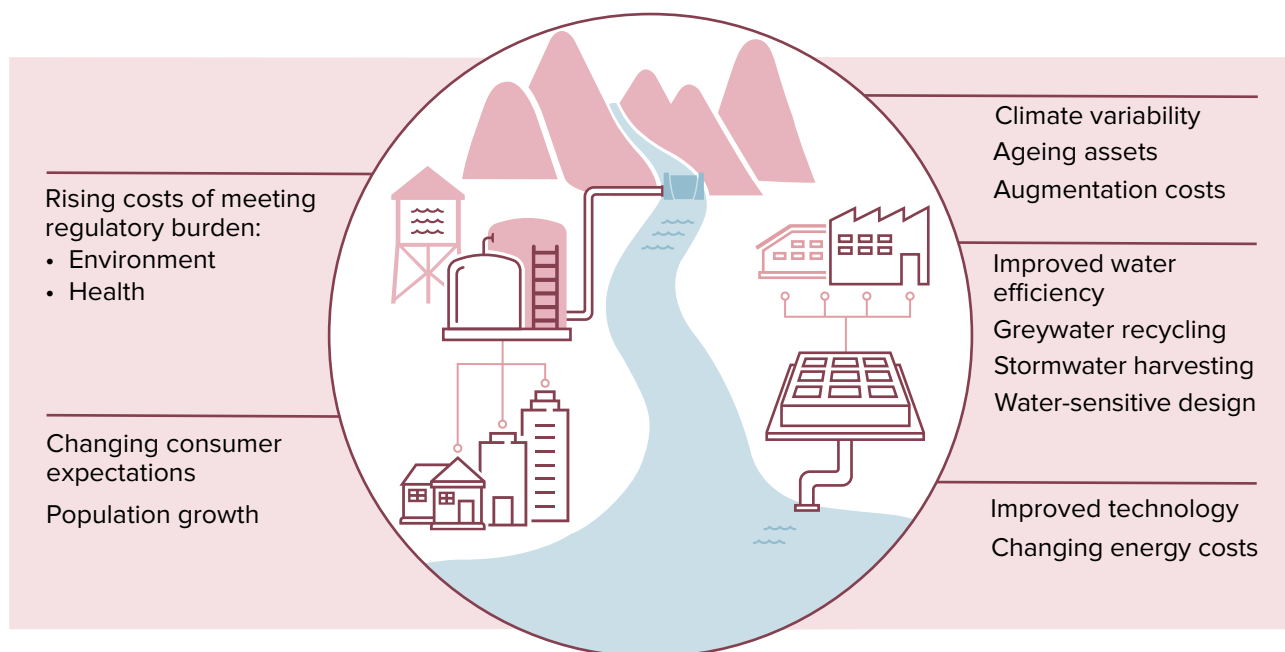
Failing to address these issues could lead to higher costs and a decline in service quality.

The urban water sector faces a range of challenges

Users in urban areas typically receive high-quality water and wastewater services. This reflects the success of metropolitan water utilities in overcoming the unique challenges of Australian geography and climate, and providing safe, clean, reliable and affordable water, wastewater and integrated water-cycle services.

However, urban water faces a number of substantial challenges over coming years. In order to continue to provide safe, reliable and affordable services, the urban water sector will need to adapt to the changing needs of Australia's cities and towns. As shown in Figure 2, these challenges include a changing climate, population growth and densification in cities, ageing assets, increasing concern over the health of our waterways, and shifting community expectations.

Figure 2: A snapshot of factors influencing urban water bills



Population growth is ramping up pressure on limited water supplies

While climate change is tightening water supplies in many parts of the country, our population has grown rapidly, with growth concentrated in urban areas. This trend is likely to continue, with the population of all capitals projected to grow faster than the balance of their respective state or territory.⁴⁰ Impacts will be felt most in the south-eastern regions, where the joint factors of population growth and climate change are expected to be most pronounced.

Water planning on the basis of long-term population growth projections is problematic, with the growth of our major cities consistently underestimated. Analysis by the water industry in 2010 projected that water consumption in Australia's six largest cities would increase 39% by 2026 and 64% by 2056 – a total increase of around 1,000 gegalitres each year.⁴¹ However, these estimates were based on population projections that were on average 18% lower than the most recent estimates by the Australian Bureau of Statistics (ABS).⁴²

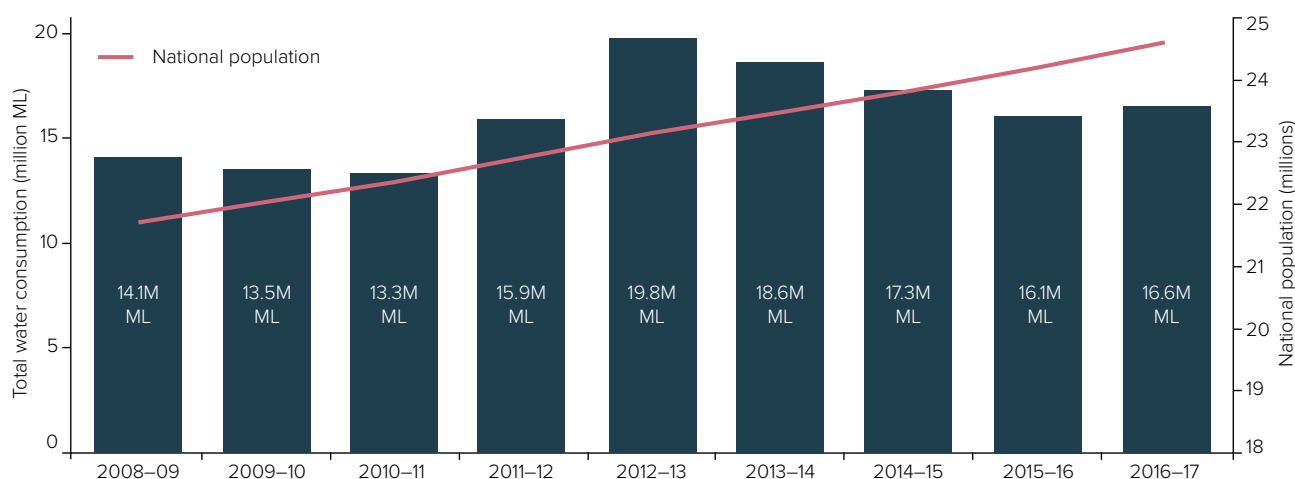
Australia has the highest per capita surface water storage capacity of any country in the world.⁴³ As at January 2019, capital city water storages were at between 48% (Perth) and 88% (Hobart).⁴⁴ Sydney's combined water storage has dropped 40% over the last two years.⁴⁵

This does not fully reflect the water security position of Perth and Hobart. Groundwater extraction provides around 40% of water for Perth, while only around 10% of its water comes from surface water.⁴⁶ The majority of Hobart's water supply is sourced directly from rivers, with only a small portion sourced from surface water.⁴⁷ Pressure on water supplies has been eased by Australians consuming less water since 2012-13 as reflected in Figure 3.

Most Australian cities have sea water desalination capacity, which was built between 2007 and 2012 in response to the Millennium Drought. Most of this capacity has been underutilised since construction, with the exception of Western Australia, where it provides approximately half of Perth's supply and is being used to replenish aquifers as part of a broader integrated water supply scheme.⁴⁸ Drier conditions over recent years have led a number of other major cities' utilities to initiate supply – or prepare for initiation – from their desalination facilities, including in Adelaide, Melbourne and Sydney. This is likely to ramp up over the coming years as water storage levels decline and water utilities prepare for drought.

Existing storages, groundwater and surface water – supported by desalination facilities – are expected to be able to cater for demand in the medium term. Governments and utilities will need to look beyond traditional surface water and bulk water storage options to continue to cater for growth and demand, because of limited potential new sites and their inability to adapt to climate variability. However, there is significant scope to adapt to growing demand through increased water efficiencies and a diverse portfolio of water supply sources.

Figure 3: Decrease in water consumption since 2012-13 has eased pressures on supply



Source: Australian Bureau of Statistics (2019)⁴⁹

Climate change is affecting patterns of water supply

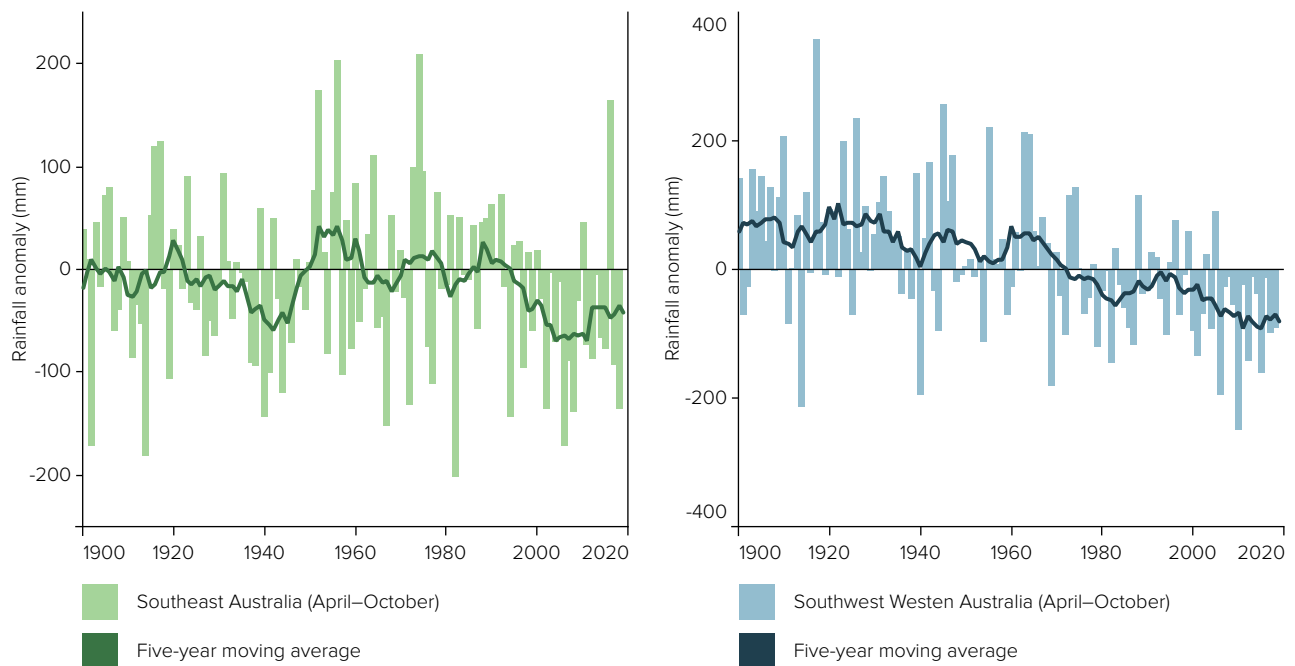
Climate variability and change is having a substantial and growing impact on Australia's water sector. In particular, southern regions are experiencing progressive drying that cannot be explained by natural variability alone. Southeastern regions and southwestern Australia have experienced significant longer-term rainfall decline over the past half-century, particularly during the cooler months. Notably, south-west Western Australia has recorded a 26% decline in rainfall over the last two decades against the long-term average. Northern Australia, on the other hand, has become wetter across all seasons.⁵⁰

This is having substantial impacts on southern water storages (Figure 4). The reduction in average winter rainfall in south-west Australia has caused a 50% reduction in runoff over the last half-century,⁵¹ while declining streamflows have been observed across

southern and southeast regions, including Sydney, Melbourne, Perth and Adelaide.⁵² This trend is expected to worsen over the medium to long term.⁵³

Reduced streamflows will provide less water into bulk water storages, while changed rainfall patterns will place a higher reliance on rain events in the warmer months, which are typically drier.⁵⁴ Groundwater could also be at risk of reduced recharge from lower runoff and less infiltration as supply is increasingly expected to come from heavy rainfall events. Warm, dry weather also drives higher water consumption and the potential for over-extraction of groundwater by communities and agricultural producers during times of surface water shortage.⁵⁵ There is also increasing concern over the impact of degraded catchments and regrowth in water supply catchments after bushfires. Increased infiltration into the soil and increased water use by developing vegetation can significantly reduce water runoff into bulk water storages.

Figure 4: Winter rainfall has declined in southwestern and southeastern regions over recent decades



Source: Commonwealth Scientific and Industrial Research Organisation and Bureau of Meteorology (2018)⁵⁶

Climate change also poses heightened risks for assets

The risks of climate change extend beyond water security, and include the impacts of more extreme weather events on water and wastewater assets.

Across most parts of the country, rainfall events are likely to increase in frequency and each event is expected to become more intense and concentrated across fewer rainfall days.⁵⁷ This brings increased risks of floods from very short duration rain events. These can test the capacity and resilience of assets – most particularly stormwater systems, treatment plants and sewerage networks – and bring risks to public health from poor raw water quality and increased wet weather overflows from sewers.

Bushfires in water supply catchments and large flooding events can present a significant risk to water supply quality as debris and sediments are washed into rivers and dams. This results in poor raw water quality, which can reduce the water supply capacity of water treatment processes and in more severe events, water treatment plants may need to be turned off for up to several days until raw water quality improves, interrupting water supply to customers.

Increased temperatures – and particularly very hot days – increase evaporation from storages. Combined with nutrient runoff from heavier rainfall events, hotter weather also increases the risk of bacterial contamination and blue-green algal outbreaks.⁵⁸

Older assets will require a step change in replacement and upgrade

Compounding the challenges of climate change and population growth, the water and wastewater infrastructure networks in our cities were largely designed and built many decades ago for very

different cities of a much smaller scale. This infrastructure has served Australia well, but with so much of Australia's water and sewerage network built over the first three-quarters of the twentieth century, utilities are expected to require an increasing level of investment to replace ageing assets.

More people living in multi-unit dwellings in established areas of cities introduces some efficiencies in water and wastewater service provision by making better use of existing assets, however this also places increasing pressure on legacy trunk network assets.

Preventative maintenance and changes to household demand behaviour could delay major investments in urban water and wastewater infrastructure. However, sooner or later, the renewal and augmentation of these assets is likely to come at significant cost. Assets in major cities are likely to be most costly, since urban development has made accessing and upgrading trunk assets difficult, and construction will cause disturbance to local businesses and residents. Some utilities may struggle to finance the upfront costs of these renewals, and users may be faced with rising bills to fund upgrades over time.

Timing is critical. Failure to renew these assets could attract significant financial and economic costs, but it is important to ensure users are not hit with unnecessary upfront costs. Investing too soon could fail to extract maximum value from existing infrastructure. On the other hand, ageing assets will lead to higher operational and maintenance costs, and the impact of a failure in trunk water and wastewater infrastructure in fast-growing cities is likely to be significant. Transparent reporting on these assets will be critical to ensuring asset renewal processes are efficient, and so that governments, utilities and regulators are accountable for their decisions.

168. Opportunity

Imminent renewals of ageing assets bring an opportunity to rethink how water and wastewater services are delivered, and to use technology to improve efficiency and levels of service. Renewals could help to avoid overinvestment in large, long-lived traditional water and sewerage assets, and make the system more adaptable to future trends and shocks.

When this will impact:



Where this will impact:





Failing to address these challenges could lead to rising costs for taxpayers and users

Household water and sewerage bills across the country are generally affordable. However, pricing restrictions mean that many users do not appreciate or pay the true cost of the water they consume, or for disposal of the wastewater they create. Also, as with the electricity sector, the water and wastewater assets are typically expensive and long-lived, with significant investment in long linear assets required in coming years. Efficiently meeting future needs will be essential to minimise the impact on household budgets. Without action by governments, regulators and utilities, bills could rise substantially over the next five to 20 years.

With the value of water poorly understood, governments have been reluctant to embrace the pricing reforms that are required to properly reflect the cost of provision and support rational investment. Prices that better reflect the cost of water provision assist in managing demand for water and encourage operating cost efficiencies, facilitate investment, and provide a better basis for private sector participation in the urban water sector.

The combined impacts of climate change, population growth, rising community expectations and ageing networks mean that costs of providing services are likely to put upward pressure on household budgets over coming years. Infrastructure Australia's *Reforming urban water* report found that these factors could have significant impacts on users' bills if not addressed – without action, bills could rise by around 50% in today's money within 10 years, and double by 2040.⁵⁹

169. Challenge

The urban water sector faces considerable risks, including the impacts of climate change, population growth, ageing assets, and changing needs and expectations from users. Failure to adequately address these challenges could lead to rising water bills, as well as exposing users to risks of declining service quality and reliability.

When this will impact:

0-5

5-10

10-15

15+

Where this will impact:



9.3 Sustainable water for liveable cities

At a glance

Governments and service providers are increasingly aware of the role water plays in sustaining our communities. As urban areas become denser, household water costs will rise, as will the demand for lakes, rivers and fountains to refresh our public spaces.

This section outlines how smarter use and planning can unlock potential in our cities:

- Existing water bodies, such as dams and reservoirs, can double as recreational spaces.
- Decision-makers can coordinate better to include water assets in our urban planning.
- Households can use water more efficiently.
- We can use recycled water to reduce pressure on potable supplies.

Water underpins the liveability of our cities

Water is critical to the liveability of our cities and towns. Drinking water sustains life, while access to water allows for sanitation and hygiene, and stormwater management reduces the impact of extreme weather events. Access to waterways improves our sense of wellbeing and provides recreation opportunities. It also supports green infrastructure such as playing fields, parks, gardens and tree canopies. Green space and bodies of water also reduce the urban heat island effect, making cities and towns more habitable without artificial cooling.

There is evidence that many Australians place a high value on water in the urban environment:

- People value access to open space and are prepared to pay up to 16% more for a house with greater access to open space.⁶⁰
- City residents place a high value on stormwater projects that restore stream quality, with Sydney and Melbourne residents willing to pay between \$104 and \$278 per year on average.⁶¹
- Many households have also invested in local harvesting and reuse systems. For example, the proportion of suitable dwellings with a rainwater tank rose from 24% in 2007 to 34% in 2013. This growth was largely attributed to water restrictions, strengthened building regulations, government rebate schemes, and a stronger desire to conserve water and reduce bills.⁶²

Australians' desire for increased liveability has partly resulted in urban encroachment on water and wastewater assets. This encroachment is becoming an increasingly important issue for water service providers. Gradually, land use buffers around major water and wastewater assets have been reduced due to urban development. For example, the wastewater treatment plant at Macquarie Point in Tasmania was relocated due to development opportunities, increased liveability aims and investment potential around the Museum of Old and New Art in Hobart.⁶³

Smarter use of water could unlock new recreational spaces in cities

Urban densification is shifting demand for water in our cities. Greater urban density brings a reduction in private open space, and increased demand for public space. Access to quality open space is an important driver of standard of living in dense urban environments. Green space and tree canopies refresh the air and are known to enhance mental wellbeing. Parks, public gardens and sporting fields allow for community interaction, exercise and reflection.

With growing demands on our public recreational space, options for broadening access to previously restricted bodies of water could provide public benefits without significant capital cost. This may be particularly relevant where urban expansion has seen new residential communities develop in proximity to what had previously been relatively remote dams and reservoirs, or for dams that provide secondary sources of storage. Through engagement with local Aboriginal and Torres Strait Islander communities, it may be possible to provide access in urban areas for cultural purposes.

Rehabilitation of degenerated waterways can also provide for multiple sources of recreation, such as swimming and boating where they were not previously feasible because of safety and public health concerns. An example is Lake Parramatta in New South Wales, which was reopened for public recreation in 2015 after being closed for 72 years due to poor water quality.⁶⁴

Water could be better integrated in urban planning

Water reforms have focused water service providers on financial efficiency and regulatory compliance, which has delivered good financial outcomes. However, policy and regulatory frameworks do not adequately identify where the costs and benefits of broader economic and social outcomes lie and how costs should be shared with these beneficiaries. This affects how water is integrated in broader urban planning.

Australia's three levels of government present further challenges to delivering liveable communities. The Australian Government has a strong influence in the planning and growth of major cities without necessarily having a regulatory or legislative mechanism facilitating direct intervention. State, territory and local governments share many aspects of the planning process, often without effective coordination. Delivery and regulation of water services regions is largely fragmented across levels of governments, undermining coordinated and consistent decisions about water's role in place-making and planning.

Responsibility for infrastructure and services is generally allocated on a sector basis, such as transport, land-use planning and water. The current approach to land-use planning focuses development primarily around transport nodes, leaving water service provision and access to waterways as an afterthought. This was highlighted in Infrastructure Australia's *Planning liveable cities: A place-based approach to sequencing infrastructure and growth*, which identified the need to improve planning and delivery processes to accommodate growth, particularly through integration and coordination of strategic metropolitan plans.⁶⁵

Some governments are seeking to address this issue, for example:

- The South Australian Government included water as a principle for planning and design as part of the broader reform of land-use development and planning in the SA Planning Commission's *Natural Resources and Environment Policy Discussion Paper*.⁶⁶
- In Western Sydney, the Greater Sydney Commission is exploring water-centric development. This approach puts water features, such as waterways, as the focal point for urban planning, with transport nodes and access to other facilities planned around it.⁶⁷



170. Opportunity

In increasingly dense cities, water will need to play a growing role in supporting our cities as desirable places to live, work and visit over coming years. Better understanding water's role in urban environments could enhance quality of life, open new spaces for recreation, natural regeneration and cultural practices.

**When this
will impact:**



**Where this
will impact:**



Households could use water more wisely

Australian water consumption rates remain high by world standards. While this reflects our relatively harsh climate, it is also a function of a historical reluctance to live within our means in terms of the water demands of city planning, garden design and lifestyle choices.

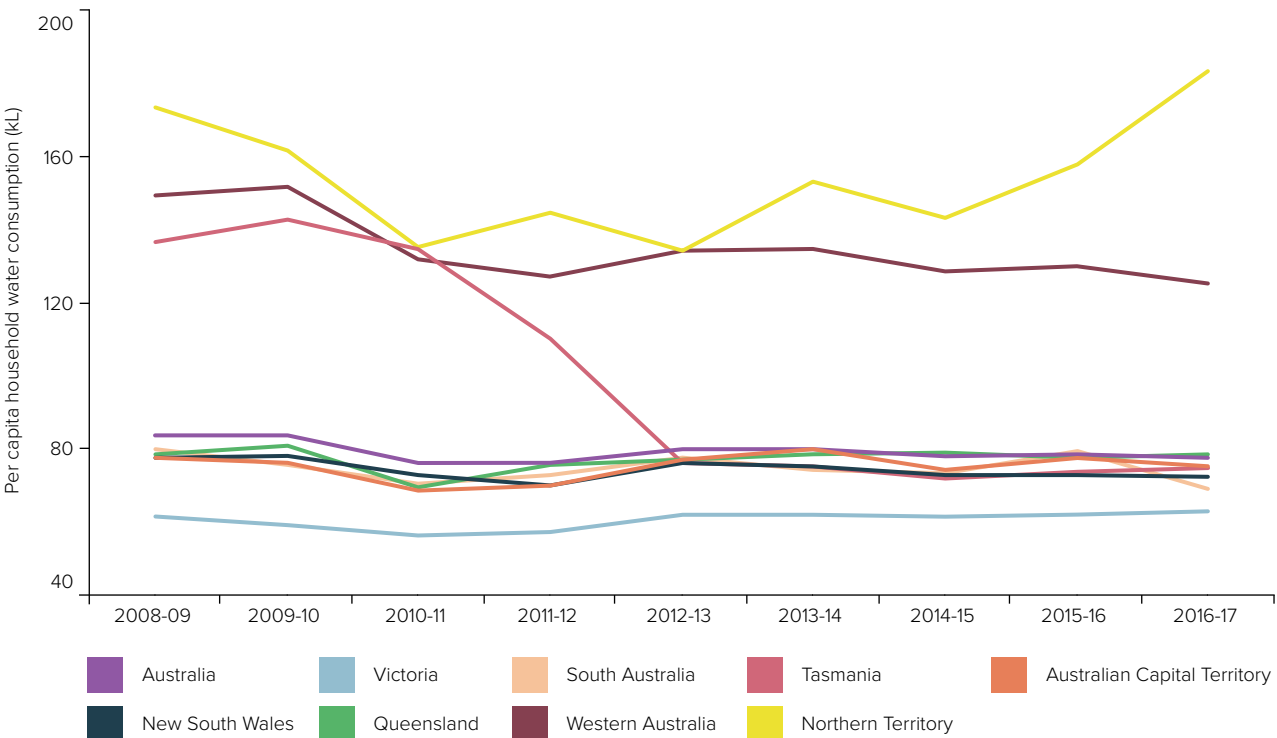
The consumer response to water restrictions and ongoing curtailing of consumption under ‘water-wise’ rules demonstrates that we are capable of changing behaviour in the face of a water supply crisis. Australian household water consumption fell 16% over four years to 2008-09⁶⁸ in response to the Millennium Drought.

However, water restrictions can have adverse impacts on some urban areas, particularly through limited water for outdoor use. When dry and brown, gardens and lawns can be hotter than concrete

pavement. Keeping green spaces green, especially during drought, creates a difficult trade-off between water efficiency and liveability.

While there have been some improvements in household water efficiency, these have tapered off as water security risks – and the public awareness campaigns that came with them – eased. As Figure 5 shows, after declines to 2008-09, capital city water use per person remained relatively stable across the eight years to 2015-16. New South Wales, Queensland, South Australia and the Australian Capital Territory display similar usage patterns, but there remain large discrepancies between jurisdictions – households in Sydney and Perth use almost 50% more water than in Melbourne.⁶⁹ Large changes in water use behaviour are possible. Tasmanians almost halved their water use over the period, during which volumetric pricing was introduced.⁷⁰

Figure 5: Per capita water consumption by households has remained stable over recent years



Note: Values shown are total water consumption by households (excludes consumption by industry) divided by the estimated population.

Source: Australian Bureau of Statistics (2019)⁷¹

Recycled water can play a greater role in supporting liveability

There is scope for making better use of recycled and grey water and stormwater sources in urban areas. Household systems that allow for greater use of non-potable water by households for outdoor use, flushing toilets and other activities, could preserve potable water for applications that require it. Advancements in stormwater harvesting technologies allow for greater use of stormwater for non-potable applications in urban areas, such as water for sporting fields, gardens and nurseries.

The primary shortcomings of decentralised recycled water schemes are their fragmentation and high capital cost from duplicative distribution and reticulation networks. As potable reuse of recycled water grows, there is a risk that decentralised infrastructure to treat and deliver recycled water to customers will become redundant. Direct potable reuse could provide an additional non rainfall-dependent water resource that is cheaper to produce than desalination and a more flexible part of water networks than decentralised schemes.

With direct potable reuse, recycled water is injected directly to the water supply distribution system, either downstream of the water treatment plant, or into the raw water supply immediately upstream of the water treatment plant.⁷² More than three-quarters of water industry participants consider that recycled water can be treated and managed to a level that is suitable for potable supply.⁷³

Recycled water for potable reuse is typically less costly to produce than desalinated water.⁷⁴ The process for both potable reuse and desalination is through reverse osmosis, which uses energy to push water through fine membranes. The difference in costs stems from the higher energy costs to treat seawater. Despite the potential benefits of potable reuse, some members of the community remain concerned about risks to public health. Further community engagement is likely to be required to support social licence for potable reuse.⁷⁵

Examples of integrated water cycle management

A range of decentralised recycling schemes are in place in Australia, such as in Kwinana for industrial use in Western Australia, the Virginia Scheme for agricultural use in South Australia, and Gippsland Water Factory serving industrial and agricultural purposes in Victoria. Even where not producing potable water, such schemes can be valuable in conserving high-quality water for household use, providing environmental flows and recharging groundwater, and improving public perception of recycled water use.

There are also limited examples of dual reticulation recycled water schemes for households. Thirty-two thousand properties in Rouse Hill in Sydney's north west are connected to a third pipe scheme that provides recycled

water for gardens and toilets, preserving fresh water for drinking, cooking and showering.⁷⁶ South East Water in Victoria operates a recycling scheme that, as well as servicing agricultural users, provides 11,000 residential customers with water for gardens, toilets and laundries.⁷⁷

Water Corporation in Western Australia has been operating Australia's first full-scale Groundwater Replenishment Scheme since 2017, a potable reuse scheme where treated wastewater is further treated to drinking water standards, and recharged into Perth's deep aquifers.⁷⁸ This scheme currently supplies 2% of Perth's water needs.

171. Opportunity

Governments and utilities have not fully explored options for greater efficiency by households and industry, including potable reuse. More efficient household usage and industry service provision could provide substantial benefits for users at low cost.

**When this
will impact:**

0-5

5-10

10-15

15+

**Where this
will impact:**



9.4 Water and wastewater in regional and remote communities

At a glance

This section looks at service standard gaps outside cities. Less populated areas face unique challenges, and not addressing them could harm communities and the economy. A lack of data makes it hard to track performance or identify problems. Since isolated communities occupy some of Australia's most arid regions, water security is also a key concern.

As challenges increase, so will the costs. Water bill revenue from small communities will not be able to cover this, and small utilities also lack the expertise or the funding incentives to overcome these challenges.

Remote water services in some areas do not meet acceptable standards, and Aboriginal and Torres Strait Islander communities are strongly affected by the shortfall.

Regional water and wastewater utilities face considerable challenges

Water and wastewater utilities in less populated regional and remote communities – including smaller towns, rural communities and remote areas – face service delivery challenges that are unlike those faced in metropolitan areas and smaller cities like Bendigo, Newcastle and Townsville. Regional utilities typically serve relatively small customer bases, many of which are dispersed over large areas. In some areas, the population is declining, which means that already small customer bases are shrinking. Many regional utilities are situated in areas with lower than average rainfall or streamflow, and have limited or no connection to other utilities or water sources.

In regional New South Wales and Queensland, urban water and wastewater services are provided by local councils. Many of these utilities serve relatively small populations, including 115 utilities in New South Wales and Queensland that have fewer than 10,000 connections. Of these, at least 48 utilities have fewer than 1,500 connections (Figure 6).⁷⁹

This presents challenges for urban water delivery in regional areas keeping pace with the advancements in cities. Whereas large cities may seek to enhance liveability through water supply and invest in a

range of new technologies to benefit users and built environments, regional utilities are unlikely to have the same capacity to invest and develop.

Failure to address looming challenges in regional areas could see heightened water restrictions for users, decreased utility of recreational spaces such as parks and waterways, and adverse impacts for business activity and investment. Overcoming gaps in service standards outside of our cities will be integral to the sustainable growth of their populations over the long term.

Water security is a key concern in regional areas

Many regional utilities rely on a single supply source, with no physical link to neighbouring utilities' bulk water supply. Unlike metropolitan areas located on the coast, climate-independent supply sources like desalination are generally not viable sources of supply in inland regional areas.

Water resource planning seeks to establish the amount of water available for consumptive and non-consumptive purposes. However, challenges remain for regional communities to fully participate in complex water planning processes. Overlapping federal, state and territory planning and regulatory processes add to this complexity.

Figure 6: Australia's smallest utilities are in Queensland and New South Wales



Source: Productivity Commission (2017) and Essential Services Commission of South Australia (2020)⁸⁰

Urban water authorities are increasingly becoming active participants in water markets, both as buyers and sellers. In average and wet years, some regional urban water providers are selling into the allocation (temporary) market. However, during low allocation water years, regional utilities are more likely to enter the market to buy water allocations to supplement urban supply. An example of this occurred in 2008-09 when the South Australian Government bought temporary water allocations to secure urban water supplies for Adelaide.⁸¹ While the market provides opportunities for some regional providers to augment supply in the short-term, there is a challenge around the capability of service providers to make informed market decisions that optimise supply security and cost.

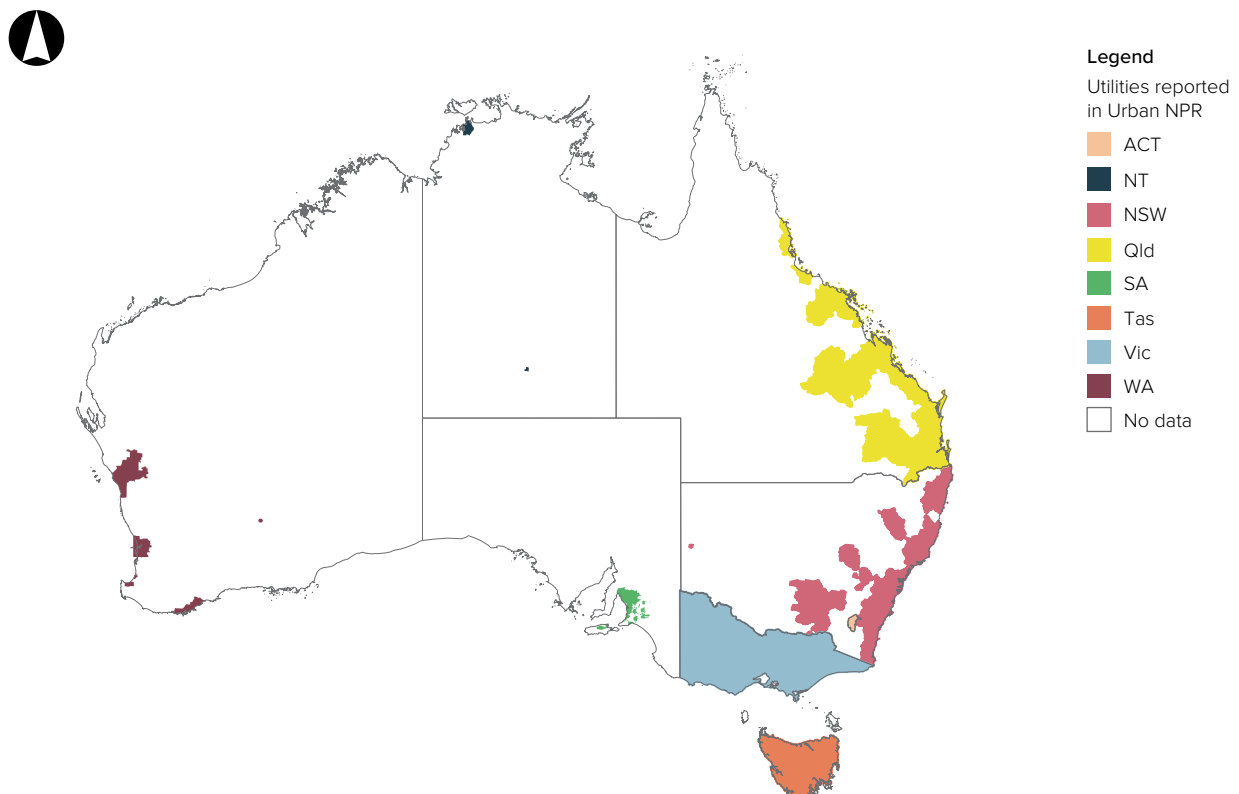
Constraints on water security directly relate to constraints on development and quality of life in regional areas. Without appropriate supply diversification and planning, water security could become a significant driver of regional settlement patterns, particularly in the coming decades as climate change impacts manifest.

Information on services in many areas is inadequate

Despite the importance of providing safe, reliable and efficient services to small towns, rural communities and remote areas, tracking expenditure and benchmarking the performance of smaller regional utilities is not possible. Where monitoring of expenditure and performance does occur, the results are not always published.⁸² Utilities with fewer than 10,000 connections are not included in the Bureau of Meteorology's *National performance report*, and those utilities that do report often provide unreliable and inconsistent data, as shown in Figure 7.⁸³

Given the significant challenges facing many utilities, the focus of many regional and remote service providers on day-to-day operations is understandable. Many local water managers are performing well under difficult circumstances. However, a lack of reliable reporting makes it difficult to identify where problems are most immediate, understand the most efficient way of meeting challenges, and plan to meet each utility's needs over the long term.

Figure 7: Large parts of Australia are not covered in the *National Performance Report*



Source: Bureau of Meteorology (2019) and SA Water (2020)⁸⁴

A lack of scale and expertise compounds regional challenges

Many regional areas lack the expertise to overcome the challenges they face. Smaller councils find it difficult to attract and retain skilled staff, and to keep pace with advances in regulation and asset management. Many utilities lack the capacity to invest in technologies that save costs or improve services.

Industry collaboration across regional areas has helped to overcome these challenges. Queensland and New South Wales have implemented collaborative initiatives such as the Queensland Water Regional Alliance Program and voluntary collaborations such as the Central NSW Councils. These alliances allow resources to be pooled to undertake research projects and collaboration initiatives to reduce costs, improve efficiency and plan for future needs.⁸⁵ In other jurisdictions,

governments have amalgamated utilities to build economies of scale:

- Between 1982 and 1994, Victoria moved from over 400 local utilities to 15 – and then further rationalised to 13 in 2005.⁸⁶
- In Western Australia and South Australia, single water corporations deliver water and wastewater services to the majority of the population.
- In Tasmania, utilities were progressively rationalised from 21 prior to 2009 to the present TasWater in 2013. The legacy of this history is still reflected in Taswater's asset base, which includes 47 water treatment plants, which dwarfs the inventory of Sydney Water (9 water treatment plants) – which serves over nine times the customer base.⁸⁷

172. Challenge

Regional and remote utilities face considerable challenges, including reliance on a single source of supply, limited resources, a lack of scale and unreliable information on services. Failing to adequately address regional water challenges could lead to heightened quality or reliability risks and a deterioration of liveability in regional and remote areas.

When this will impact:



Where this will impact:



Funding regional water needs efficiently is a growing challenge

The scale of investment required is likely to be substantial. For example, analysis undertaken in regional Queensland has forecast increasing failure of water mains commencing in the 2020s and peaking in the 2040s as these pipes approach the end of their useful life. At current renewal rates, it would take over 170 years to replace the mains alone, which make up approximately 38% of the 42,000 km of water mains and 22% of the 33,500 km of sewer pipes owned and operated by regional Queensland Councils.⁸⁸

Average costs of service provision per connection in regional areas are already higher than metropolitan areas. Median capital expenditure on water infrastructure per property for small utilities in 2016-17 was \$293 – almost double that of major utilities (\$151 per property).⁸⁹

This cost discrepancy is likely to grow. Many regional and remote utilities are faced with ageing water and wastewater infrastructure. In some cases, assets no longer comply with environmental and health standards. Greater investment in maintenance and renewal of water and sewage networks will be required to maintain and improve levels of service. Increasing electricity costs and more stringent environmental regulations are also placing additional upward pressure on service delivery costs.

The National Water Initiative requires full cost recovery for water and wastewater services to ensure the financial viability of water service providers. However, this national agreement acknowledges that cost recovery for some small communities, particularly those in rural and remote areas, may not be practical or achievable. Full cost recovery has, and will likely continue, to remain out of reach for many regional water and wastewater utilities.

Capital grants have been provided to utilities that clearly require support to fund new infrastructure. However, a lack of reliable data on the performance of all regional utilities – particularly in terms of cost recovery measures – makes it difficult to identify which utilities have the greatest requirement for grant assistance. The Productivity Commission found that capital subsidies in New South Wales and Queensland have also funded infrastructure in larger regional towns and cities that could have been funded through user charges. These subsidies are inconsistent with the National Water Initiative pricing principles.⁹⁰

While capital grant programs to regional areas have a role to play in maintaining service standards, a lack of robust and independent economic or pricing regulation could lead to inefficient investment. Grant funding for specific capital projects also raises risks of over-investment in new assets when other options such as demand management or targeted maintenance programs to extend the life of existing assets could be more efficient and beneficial to local users.

173. Challenge

Many regional and remote utilities face mounting costs to maintain, renew or upgrade ageing water and wastewater assets, but have limited funding through grants or revenue. Where funding is provided, it is often inefficient or lacks transparency. Failure to provide sustainable funding could lead to declining reliability and quality for regional customers, heightened risks of asset failure, and a mounting funding backlog.

When this will impact:

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Where this will impact:



Services in some remote areas do not meet acceptable standards

Remote communities are unique and challenging environments for service provision. Many are predominantly or entirely home to Aboriginal and Torres Strait Islander peoples.⁹¹ Of the approximately 1,000 discrete Indigenous communities in remote areas, more than three-quarters have a population of fewer than 50 people.⁹²

Reliable and safe drinking water and wastewater services are vital for the wellbeing and long-term sustainability of these remote communities. This includes meeting remote communities' needs to maintain hygiene and to limit the spread of disease. In turn, this can reduce the cost of providing health services. Water and wastewater services are also critical to meeting broader policy objectives, and to underpin progress towards a number of Closing the Gap targets.⁹³

Water and wastewater assets in some remote communities are poorly maintained, routinely fail, or provide services at a standard below their intended design. In 2014-15, around 19% of Aboriginal and Torres Strait Islander households in areas classified as very remote lacked access to working facilities for washing clothes or preparing food. Around 6% lacked access to working facilities for washing.⁹⁴ Leaks and blockages can take weeks or months to be fixed due to a lack of technicians or parts and limited access to some communities, particularly during the wet season. There is evidence of poor maintenance of existing wastewater treatment facilities.⁹⁵

Water quality monitoring in many areas is also inadequate. Across the country, Australian Drinking Water Guidelines provide clear guidance on standards for service providers,⁹⁶ but independent audits of compliance in remote communities are relatively infrequent and often limited in scope. When they are undertaken, their findings are rarely publicly disclosed, and often fail to take into account local water needs, which may vary depending on cultural values and preferences.

The value of water to communities can have strong indirect benefits. Improved access to swimming pools in remote Aboriginal communities, such as Jigalong and Burringurrah, has created significant health, societal, educational and emotional benefits for children.⁹⁷ In the Northern Territory, Queensland, South Australia and Western Australia, drinking water in remote communities is predominantly supplied from groundwater sources. Many of these groundwater sources have high concentrations of naturally-occurring minerals and chemical contaminants that affect water quality.⁹⁸

As a result, many remote communities have water quality levels that fail to meet the Australian Drinking Water Guidelines. For example, over a two-year period between 2012 and 2014, at least one remote Aboriginal community in Western Australia (of those which were tested) failed to meet the Australian Drinking Water Guidelines each month, with either E.coli or Naegleria bacteria detected in the water source.⁹⁹



Australia is not meeting Sustainable Development Goal 6

There is clear evidence that services in many of these remote communities do not meet United Nations' Sustainable Development Goal (SDG) 6: clean water and sanitation for all.¹⁰⁰ SDG 6 includes commitments to:

- achieve universal and equitable access to safe and affordable drinking water for all
- achieve access to adequate and equitable sanitation and hygiene for all
- support and strengthen the participation of local communities in improving water and sanitation management.¹⁰¹

Failure to meet the Goal has occurred despite the Australian Government being a signatory to the SDGs. Reporting has indicated that 100% of the population have access to safe water and sanitation, however this is acknowledged by the Australian water industry as inaccurate.¹⁰² These issues predominantly impact Aboriginal and Torres Strait Islander peoples.

Australian representatives provide advice to other Asia-Pacific countries on how they can meet SDG 6,¹⁰³ while issues with access to clean water and sanitation persist in our own backyard. Our overseas outreach programs are evidence that the Australian water industry and governments have the skills, expertise and resources required to do better by our own people, to address these issues, and to ensure Australia meets its international commitments by 2030.

174. Challenge

Some remote communities, many with predominantly Aboriginal and Torres Strait Islander populations, do not have access to reliable and safe water and wastewater services, while monitoring is often inadequate. Failure to address these issues will erode social and physical wellbeing, reinforce disadvantage, and undermine our national and international commitments and objectives.

When this will impact:

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Where this will impact:



9.5 Water oversight, regulation and decision making

At a glance

Water infrastructure is expensive, but its value is poorly understood. Decision making suffers from:

- poor performance reporting and data collection
- inconsistent governance and pricing
- a lack of transparency and user engagement
- weak long-term planning for our urban water supply.

This section discusses the impacts of these challenges and how we can address them.

Water infrastructure decision making requires more rigour

Water and wastewater infrastructure are capital intensive and long-lived. Water is expensive to store, treat and deliver and a high proportion of costs are fixed. It is therefore critical that the value of water infrastructure investments is defined and assessed and that investment decision making is sound. This means ensuring that the right water infrastructure is in place in the right locations at the right scale and at the right time.

The National Water Initiative, developed in 2004, provides objectives and guidelines for urban water management across the country. However, there is evidence that these principles have declining relevance. For many utilities in fast-growing cities, the National Water Initiative no longer provide useful targets for ongoing improvements. For some smaller regional utilities, principles such as full cost recovery may not be meaningful targets. In 2017, Infrastructure Australia called for a new urban water reform agenda, and amendment of the National Water Initiative to focus solely on rural water.¹⁰⁴

Contrary to National Water Initiative objectives, some capital grant programs have funded water infrastructure projects that do not demonstrate economic viability. This is despite funding being available to support planning and feasibility assessment of projects, and guidelines for project funding requiring a robust business case and demonstrated economic merit in order to proceed to full funding.¹⁰⁵

Identifying, quantifying and communicating the benefits of water infrastructure remains an area where further improvement is warranted. Better decision making on water infrastructure requires a better understanding of the benefits these projects can bring, and communication of these benefits through business cases.

Urban water performance reporting and data is not fit for purpose

Urban water data is compiled at the federal level by the Bureau of Meteorology through the annual National Performance Report (NPR) Framework, in collaboration with state and territory governments and the Water Services Association of Australia. The Bureau of Meteorology is currently undertaking a review of the NPR Framework.¹⁰⁶

The NPR largely focuses on network statistics, as opposed to measuring outcomes that matter to users. As the NPR Framework was agreed to over a decade ago, it no longer reflects contemporary sector objectives such as outcomes-based economic regulation, including utilities' performance in customer service and satisfaction. The structure and format of the NPR also makes it difficult to measure and report on Australia's progress against macro-level outcomes, such as the United Nations' Sustainable Development Goals. NPR indicators have not evolved with the changing needs of the urban water sector.¹⁰⁷

Information on the age, condition and capacity of urban water assets is limited. In most cities, this information is not publicly reported in a consistent manner. This makes it difficult to understand the challenges facing individual utilities, the relative priority and timeframe for replacing or upgrading ageing assets, or the total challenge facing Australia through ageing urban water infrastructure.

Accurate information on assets and service performance is important to ensure governments and operators make better decisions around the mix of preventive maintenance, repairs and replacement to get more out of existing assets for longer, and best match customer service levels with their willingness to pay.

175. Challenge

Information on water and wastewater services is not nationally consistent, reliable, insightful, or reflective of outcomes that matter to users. Inadequate information undermines effective decision-making, hides issues that impact users and limits understanding of the value of water and wastewater services.

When this will impact:

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Where this will impact:



Engagement is not sufficiently embedded in decision making processes

Decision making that incorporates community input and includes clear levels of service targets around water restrictions, sewer overflows, waterway health and triggers for future investment are important to allow adequate lead time to balance supply and demand, meet users' needs and minimise costs.

There remains significant scope for improving engagement across most utilities, many of which do not routinely and meaningfully embed users' interests and views in their decision making.

Historically, many utilities have focused on infrastructure-based solutions, which are then funded by users or through capital grants. In some cases, non-infrastructure solutions may have resulted in lower costs to the user. This is partly driven by a lack of appropriate oversight of utilities' investments, outdated approaches to service delivery, and a disconnect between decisions and customer preferences.

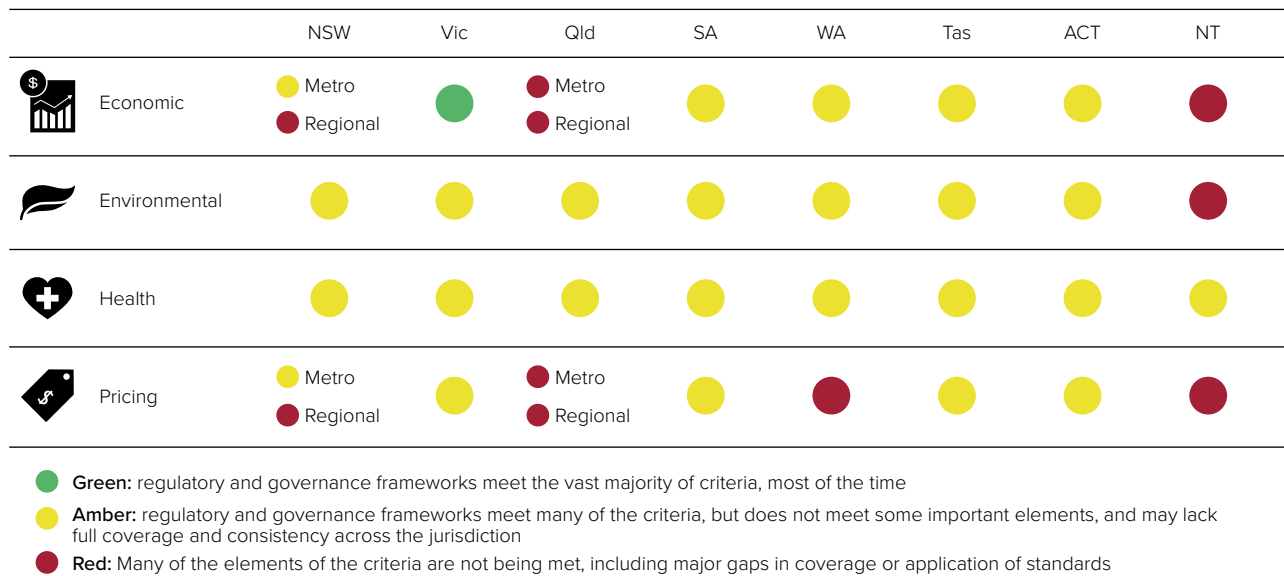
Consideration of customer preference has historically not been well captured within investment decision-making for utilities. This has started to change in Victoria, with an increased focus on customer engagement through regulatory frameworks, such as the performance, risk, engagement, management and outcomes (PREMO). The PREMO model places greater emphasis on the relationship between the utility and its customers. Utilities must demonstrate how forecast expenditure aligns with customer-driven outcomes and preferences.

Governance, regulation and pricing of urban water services can be improved

The separation of policy making, regulatory oversight and service delivery roles in the urban water sector was agreed under the 1994 Council of Australian Governments (COAG) Water Reform Framework. This agreement clarified the responsibility of governments to set clear, measurable and coherent policy objectives, with water authorities given the autonomy and incentives to make decisions that meet these objectives. This agreement also determined that service providers are to be monitored by, and accountable to, independent regulators.

In response to the 1994 COAG agreement, water utilities in metropolitan areas were corporatised but wholly-owned by government, as they remain today. The result is a notional separation which, in practice, is characterised by inherent conflicts as a result of governments being the shareholder, rule setter, operator and service provider.¹⁰⁸ Consequently, governance arrangements for urban water services do not always prioritise users' long-term interests, particularly where customer interests are mixed with other, short-term priorities. Even where arrangements are clear, these responsibilities can be blurred during challenging times, such as when there are concerns over water security or where bills are rising.¹⁰⁹

Infrastructure Australia's 2017 *Reforming urban water* paper found that no jurisdiction meets best practice across all forms of economic, environmental and health regulation, as shown in Figure 8.¹¹⁰ Across much of the country, regulation of regional and remote water delivery is weaker and of a lower standard than in metropolitan areas. Despite being agreed over two decades ago under the 1994 COAG Water Reform Framework, the fundamental principle of full cost recovery for urban water pricing is not being met universally across the urban water sector.¹¹¹

Figure 8: Infrastructure Australia traffic light summary of best practice regulation

Source: Infrastructure Australia analysis of Aither (2017) and Frontier Economics and Arup (2017)¹²

There is also a lack of clarity concerning the division of responsibility across the supply chain of water services. Water, wastewater and stormwater services in metropolitan areas are delivered by a combination of state government and local government owned water service providers, and local councils. Coordination between agencies is mixed, which frustrates the achievement of integrated water cycle management solutions.

The line between water-cycle functions are likely to be blurred over the next five to ten years. Advances in water treatment technology, as well as the challenges of growth, development and rising expectations for liveability are likely to drive water businesses and governments to reimagine the role of the water business. Providing clarity around the roles of governments, regulators and operators are likely to be vital for guiding decisions that are efficient and align with user preferences and willingness to pay.

176. Challenge

No jurisdiction meets best practice regulation and governance in urban water. Key issues include a lack of focus on user objectives, and limited coordination, accountability and independence of decision making. Issues with urban water oversight ultimately leads to poorer outcomes for users over the long term, and, without action, is likely to lead to rising bills in many areas.

When this will impact:

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Where this will impact:



Long-term urban water supply planning remains a challenge

Efficient investment in urban water supply security is in all users' interests. The costs of building and operating infrastructure will eventually be passed on to households, either directly as higher water bills, or through higher taxes or reduced government spending in other areas. A key challenge for the urban water sector is to minimise the long-term costs of maintaining an appropriate level of water supply security, while accommodating the uncertainty and pressure placed on urban water supplies by population growth and climate change. There are also other looming challenges such as the cost of managing wastewater systems under increasingly stringent environmental regulations.

Despite undergoing an extended period of drought at the beginning of the century, known as the Millennium Drought, Australia's urban water sector has largely failed to embed the lessons from this experience into planning and decision-making frameworks. With large parts of the country drought-declared and the onset of another El-Nino phase, this presents major issues for governments and utilities to manage over coming years.

In response to the Millennium Drought, governments made rushed decisions, based on mounting water security risks, to fund expensive desalination and water recycling schemes in Sydney, Melbourne, South-East Queensland and Adelaide at a combined cost of more than \$10 billion. A lack of proactive planning in water security plans meant that there

was insufficient time and capacity to pursue alternative supply options prior to committing to fund these investments. The Productivity Commission has assessed the majority of the investment in desalination capacity as potentially unnecessary or ill-timed.¹¹³

These assets have largely sat idle over recent years. The exception is Perth, where the desalination plant supplies around 48% of their water supply needs.¹¹⁴ However, they have provided an effective form of insurance against drought. After years of sitting idle, the Melbourne desalination plant has provided 76 gigalitres of potable water over the past three years, and the Victorian Government has ordered a further 125 gigalitres for 2019-20 in response to dropping water storages.¹¹⁵ The Sydney Desalination Plant also entered 'restart mode' in January 2019, and provided the first delivery of desalinated water in March 2019, as Sydney's combined dam levels dropped below the 60% trigger.¹¹⁶

Desalination is typically regarded as one of the most expensive forms of water supply, meaning it should be one of the last options considered. By contrast, many solutions that have little or no cost, including more adaptive pricing, disaggregated water meters and providing accurate usage data to users have not been fully explored in the water industry. Ensuring all options are on the table, and can be deployed when required, is likely to be essential for governments and operators to effectively and efficiently ensure secure supply over the long term.

177. Challenge

National objectives have not been updated since the Millennium Drought, despite clear lessons for the water sector during this period, and the need for long-term proactive and adaptive strategies to efficiently meet future needs. Being unprepared for another major drought could lead to reactive expenditure on additional supply assets, adding further costs to user bills and taxes.

When this will impact:

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Where this will impact:



9.6 Balancing competing needs for water

At a glance

Although water reforms have brought some benefits, many parts of the country have not reached a fair and sustainable balance between competing water needs.

This chapter considers the large role water plays in our economy, and how changing demands will impact some regional industries in the coming years. If we better study and plan for the coming changes, we can access large benefits and economic growth.

Water reforms have brought some benefits, but issues remain

Progress on water planning has been made over the past 30 years of rural water reform. Federal and state governments began implementing a number of initiatives that were specifically aimed at addressing environmental water needs in the 2000s.¹¹⁷ This included making provisions for environmental water in water planning instruments (water plans). Jurisdictions have also progressively introduced a cap-and-trade system. This approach identifies environmental water requirements, defines the total pool or share of water available for consumptive use in a given system, and provides a mechanism by which water within the consumptive pool could be re-allocated over time and between competing users.¹¹⁸

Despite substantial progress, issues with water management remain. Balancing economic, social, environmental and cultural needs for water in a manner that is scientifically robust and transparent remains a fundamental water policy challenge.

The implementation of water plans, which provide the framework for balancing competing needs for water, has been patchy.¹¹⁹ Some plans have been in place for many years, and are scheduled for review. Many surface water and groundwater plans still do not reflect best practice science and economics, and are failing to adequately balance the water needs of all stakeholders – particularly for environment and cultural purposes.¹²⁰

Extreme drought in recent years has resulted in outcomes that are inconsistent with the objectives of the National Water Initiative and the Murray-Darling Basin Agreement. For example, several fish death events occurred in New South Wales during December 2018 and January 2019. The cause of these events was a mix of extreme drought and excess upstream diversion of water for irrigation.¹²¹ In particular, decisions made by the New South Wales Government just prior to the initiation of the Murray-Darling Basin Plan (Basin Plan) enabled irrigators in the Barwon-Darling to access water

during and immediately after low-flow periods,¹²² which are likely to have exacerbated recent events. While events like this have occurred in the past, they have undermined public confidence in water management in the Murray-Darling Basin.

There are opportunities to better understand and integrate the social, cultural, and Indigenous water needs in regional Australia and the establishment of possible partnerships between environmental water managers and Aboriginal and Torres Strait Islander communities. Based on the recent federal Government commitments to improve water access for Aboriginal and Torres Strait Islander peoples in the Murray-Darling Basin,¹²³ these programs and initiatives could be extended across regional Australia.

The sustainability of water sharing arrangements for groundwater resources also need further consideration. Given increasing demand (and climate pressures) on surface water resources, groundwater use may increase in some parts of the country. As the interaction between surface water and groundwater use is still not fully understood, further research is required to ensure the sustainable use and management of both types of water resources.¹²⁴

Water management in the Murray-Darling Basin remains a challenge

The Basin Plan is the most significant Australia rural water reform, developed as a requirement of the Australian Government's *Water Act 2007*.¹²⁵ Progress has been made in the Murray-Darling Basin to address over-allocation, with over 2,000 gigalitres of water recovered for the environment through a mix of entitlement purchases and infrastructure investments.

Despite these achievements, the Basin Plan remains controversial and debate over the implementation has created significant uncertainty for all users and stakeholders. Shortcomings in the water management compliance and enforcement system have also been exposed,¹²⁶ and have undermined confidence in the Basin Plan.

Many of these issues have manifested in the unregulated Barwon-Darling system, which includes the Menindee Lakes, where fish death events recently occurred.¹²⁷ In July 2017, serious concerns were raised about the appropriateness of water sharing plan rules in the Barwon-Darling along with compliance with licence conditions.¹²⁸ This prompted a number of investigations,¹²⁹ and has resulted in a series of commitments made by the New South Wales Government aimed at enhanced metering and compliance, improved transparency and greater protection for environmental flows.¹³⁰ There have also been Basin-wide agreements aimed at enhancing compliance reflected in recent Murray-Darling Basin Ministerial Council agreements.¹³¹

Compounding this challenge is the lack of quantitative evidence of the outcomes that have been achieved through an extended period of water reform. To properly assess the benefits of water reform and inform next steps, there is an opportunity to move beyond a focus on actions, to a quantitative assessment of outcomes.

A lack of transparency on the science, data and modelling assumptions that informs decisions about trade-offs between competing uses of water in the Murray-Darling Basin has clouded the debate and slowed progress. While balancing economic, social, environmental and cultural needs for water in the Murray-Darling Basin is complex, there is an opportunity to better communicate decision making in order to facilitate productive discussions between irrigators, urban users, Indigenous communities and environmental groups.

Restoring the balance in the Murray-Darling Basin

To meet the requirements of the Basin Plan, the Australian Government is recovering water entitlements to restore the balance between consumptive water use and the environment in the Murray-Darling Basin. The basin-wide water recovery target was set at 2,750 gigalitres (expressed as a long-term average annual yield) when the Basin Plan was introduced in 2012 but was subsequently reduced to 2,680 gigalitres in June 2018 following a review of the northern Basin's environmental water requirements.¹³²

The recovery of water entitlements by the Australian Government is conducted in accordance with the Australian Government's *Water Recovery Strategy*, which was released in June 2014. Under the strategy, the Australian Government has committed to prioritising infrastructure investment and has legislated a 1,500 gigalitre cap on surface water purchases.¹³³

The rapid expansion of water buybacks between 2008 and 2012, coupled with ongoing drought, led to considerable community opposition. Many community groups noted considerable hardship and that the viability of some irrigation districts was undermined as a result of these buybacks.¹³⁴

As of 30 November 2018, the Australian Government has recovered or contracted 2,118 gigalitres of surface water against the 2,680 gigalitre water recovery target.

This equates to over 2,700 gigalitres in water entitlements that have been recovered across many of the 150 water entitlement classes that exist across the Murray-Darling Basin.¹³⁵

Overall, the Australian Government has dedicated \$13 billion to implement the Basin Plan and associated activities, of which \$10 billion has been allocated to environmental water recovery.¹³⁶ To date, the Australian Government has spent \$2.36 billion on direct water entitlement purchases and over \$4 billion on infrastructure funding projects (in exchange for water entitlements).¹³⁷

Significant work remains to fully implement the Basin Plan. There is ongoing debate about the best ways to meet the remainder of the water recovery target, and significant uncertainty associated with the sustainable diversion limit adjustment mechanism and associated projects. The Productivity Commission's recent assessment cast doubts over whether the Basin Plan can be fully implemented by 2024.¹³⁸

However, the Basin Plan has provided the opportunity to better balance the needs between consumptive use and the environment in the Murray-Darling Basin while increasing the productivity of irrigated agricultural producers and the efficiency of water delivery systems.



178. Challenge

Striking an efficient and sustainable balance between competing needs from Australia's water resources has proved problematic. Progress against past reform efforts has been significant but patchy. Failure to strike an appropriate balance in water management can lead to substantial and lasting economic, social, environmental and cultural costs.

When this will impact:



Where this will impact:



Water markets underpin substantial economic activity

Despite ongoing challenges and recent criticism, some benefits of water reform are evident in productive water markets. Water markets have become an integral part of Australia's regional economies and underpin production and growth in these regions. The structure of the Australian water markets and the various water products emerging from these markets allow agricultural producers and other industries to flexibly meet their water requirements and balance risks and returns.¹³⁹

Australia's water markets in the southern Murray-Darling Basin are considered some of the world's most sophisticated in their capacity to support economic activity. Water markets there have provided a valuable and important tool to support business operations and manage the risks of water supply variability.

The southern Murray-Darling Basin is experiencing an investment boom in permanent horticulture,¹⁴⁰ and cotton – a development that is also spreading outside the Murray-Darling Basin to Tasmania,¹⁴¹ and northern Queensland. As a result of this investment boom, the value of water entitlements in the southern Murray-Darling Basin has tripled over the last three to five years. In 2017-18, the total market value of all major surface water entitlements on issue across the southern Murray-Darling Basin was estimated to be approximately \$17 billion,¹⁴² up from just over \$7 billion in 2013-14.¹⁴³

Changing water demand will impact some regional industries

The growth in permanent horticulture and cotton is a sign that the water market is working effectively in moving water to higher valued uses, as intended through various water reform agreements. However, changes in water demand are leading to concerns about the availability of sufficient water to meet water demands of perennial horticultural developments in dry periods, and there is limited information on water demand by industry upon which investors and existing businesses can make informed decisions.

To meet the needs of new permanent horticulture in the southern Murray-Darling Basin, water will likely be sourced from industries with a lower willingness to pay for water (such as dairy and rice) and this will require both short and long-term adjustment within irrigation areas. Thus, the rate of change in agricultural production and cropping changes and its impact on irrigation and water delivery infrastructure within existing irrigation areas (e.g. Goulburn-Murray Irrigation District and Murray Irrigation Limited) needs to be considered.¹⁴⁴

The change in crop types and movement of water use between regions, combined with the requirement to deliver large volumes of environmental water, has changed historic water demands and usage patterns. This has particularly increased the complexity for river operators in the Murray River to meet competing water demands at critical peak irrigation periods and in the context of physical constraints in the system such as the Barmah Choke.¹⁴⁵ Irrigators downstream remain concerned about the likelihood of any shortfall in peak demand and how it will be met.

Despite these challenges, water markets are active and information about these markets is generally available. Available information is generally transparent enough to inform investment, although there are information asymmetries between water market participants and intermediaries, and there is a lack of consistency in the way that the state governments record and publish water trade data. In addition, water market participants in some jurisdictions frequently have to endure extensive trade processing times, particularly if trades involve more than one jurisdiction.

Ensuring that the market functions effectively and that reliable water market information is readily available will be particularly important in the short-term given the extreme drought conditions which have led to a rapid increase in allocation prices in the southern Murray-Darling Basin (up to \$700 per megalitre in the Murrumbidgee in January 2019). If drought conditions prevail, they will increase adjustment pressure across a range of irrigation businesses and industries.

179. Challenge

Changes in water demand over coming years could affect economic activity and infrastructure requirements in some regional areas. These changes may be exacerbated in drier years. In communities where there is a decline in economic activity, unemployment could rise and some assets may be underutilised or stranded, reducing productivity and growth.

When this will impact:

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Where this will impact:



Better evidence on water could underpin growth and employment

The rapid investment boom in irrigated agriculture in Australia has been highly concentrated in the Murray-Darling Basin where water resources are scarce. As water prices increase in the Murray-Darling Basin, investors are increasingly looking elsewhere in Australia for opportunities. As a result, there is potential for growth in both existing and new irrigation regions where water and associated infrastructure and supply chains are available and conditions are conducive for investment.

However, the challenge is in identifying viable opportunities and providing access to or augmenting existing water infrastructure whilst aligning it with broader infrastructure requirements and business needs. Meeting this challenge often requires significant planning, assessment and coordination. Investors in irrigated agriculture will consider a host of factors when deciding where to invest in irrigated agriculture (not just water costs) and all conditions must be conducive to achieving a reasonable risk weighed return on investment.

This challenge is highlighted in parts of northern Australia where water resources often remain untapped. This under-development is partially driven by the inability to identify suitable industries that can thrive in challenging climatic conditions, as well as a

lack of infrastructure to support new businesses and associated supply chains. Although northern Australia is ideally located to the emerging Asian markets and has an abundance of water – which remains largely unallocated – further research is required to determine appropriate crop types and growing techniques to develop viable and sustainable agricultural industries.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO), has conducted extensive research into the appropriate crop types and growing techniques in the Ord region of northern Western Australia and the Northern Territory, that has illustrated that some industry development is feasible. In the Ord region, expansion in irrigated agriculture has occurred since 2012, when an additional 7,400 hectares was released for irrigation. Also, further soil and water investigations near Kununurra identified an additional 8,900 hectares suitable for fodder or perennial crop production.¹⁴⁶ In 2014, the Western Australian Government contributed to the expansion of irrigated agriculture in the Kimberley by providing resource assessment information for 9,070 hectares of the Mantinea Development area, 30 km north-west of Kununurra.¹⁴⁷ Despite the valuable work by the CSIRO, opportunities for growth will require further consideration of broader regional development plans and strategy to realise these opportunities.

180. Opportunity

Water infrastructure could help to unlock economic opportunities, supported by evidence-based assessments that take into account potential benefits, costs and risks for industry, local communities and the environment. Further evidence on water-led opportunities could help to identify productive investments that can support growth, employment and broader public benefits.

When this will impact:

0-5

5-10

10-15

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Where this will impact:



9.7 Challenges and opportunities

Changes facing urban water

168. Opportunity

Imminent renewals of ageing assets bring an opportunity to rethink how water and wastewater services are delivered, and to use technology to improve efficiency and levels of service. Renewals could help to avoid overinvestment in large, long-lived traditional water and sewerage assets, and make the system more adaptable to future trends and shocks.

When this will impact:



Where this will impact:



169. Challenge

The urban water sector faces considerable risks, including the impacts of climate change, population growth, ageing assets, and changing needs and expectations from users. Failure to adequately address these challenges could lead to rising water bills, as well as exposing users to risks of declining service quality and reliability.

When this will impact:



Where this will impact:



Sustainable water for liveable cities

170. Opportunity

In increasingly dense cities, water will need to play a growing role in supporting our cities as desirable places to live, work and visit over coming years. Better understanding water's role in urban environments could enhance quality of life, open new spaces for recreation, natural regeneration and cultural practices.

When this will impact:



Where this will impact:



171. Opportunity

Governments and utilities have not fully explored options for greater efficiency by households and industry, including potable reuse. More efficient household usage and industry service provision could provide substantial benefits for users at low cost.

When this will impact:



Where this will impact:



Water and wastewater in regional and remote communities

172. Challenge

Regional and remote utilities face considerable challenges, including reliance on a single source of supply, limited resources, a lack of scale and unreliable information on services. Failing to adequately address regional water challenges could lead to heightened quality or reliability risks and a deterioration of liveability in regional and remote areas.

When this will impact:



Where this will impact:



173. Challenge

Many regional and remote utilities face mounting costs to maintain, renew or upgrade ageing water and wastewater assets, but have limited funding through grants or revenue. Where funding is provided, it is often inefficient or lacks transparency. Failure to provide sustainable funding could lead to declining reliability and quality for regional customers, heightened risks of asset failure, and a mounting funding backlog.

When this will impact:



Where this will impact:



174. Challenge

Some remote communities, many with predominantly Aboriginal and Torres Strait Islander populations, do not have access to reliable and safe water and wastewater services, while monitoring is often inadequate. Failure to address these issues will erode social and physical wellbeing, reinforce disadvantage, and undermine our national and international commitments and objectives.

When this will impact:



Where this will impact:



Water oversight, regulation and decision making

175. Challenge

Information on water and wastewater services is not nationally consistent, reliable, insightful, or reflective of outcomes that matter to users. Inadequate information undermines effective decision making, hides issues that impact users and limits understanding of the value of water and wastewater services.

When this will impact:



Where this will impact:



176. Challenge

No jurisdiction meets best practice regulation and governance in urban water. Key issues include a lack of focus on user objectives, and limited coordination, accountability and independence of decision making. Issues with urban water oversight ultimately leads to poorer outcomes for users over the long term, and, without action, is likely to lead to rising bills in many areas.

When this will impact:



Where this will impact:



177. Challenge

National objectives have not been updated since the Millennium Drought, despite clear lessons for the water sector during this period, and the need for long-term proactive and adaptive strategies to efficiently meet future needs. Being unprepared for another major drought could lead to reactive expenditure on additional supply assets, adding further costs to user bills and taxes.

When this will impact:



Where this will impact:



Balancing competing needs for water

178. Challenge

Striking an efficient and sustainable balance between competing needs from Australia's water resources has proved problematic. Progress against past reform efforts has been significant but patchy. Failure to strike an appropriate balance in water management can lead to substantial and lasting economic, social, environmental and cultural costs.

**When this
will impact:**



**Where this
will impact:**



179. Challenge

Changes in water demand over coming years could affect economic activity and infrastructure requirements in some regional areas. These changes may be exacerbated in drier years. In communities where there is a decline in economic activity, unemployment could rise and some assets may be underutilised or stranded, reducing productivity and growth.

**When this
will impact:**



**Where this
will impact:**



180. Opportunity

Water infrastructure could help to unlock economic opportunities, supported by evidence-based assessments that take into account potential benefits, costs and risks for industry, local communities and the environment. Further evidence on water-led opportunities could help to identify productive investments that can support growth, employment and broader public benefits.

**When this
will impact:**



**Where this
will impact:**



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10

Next Steps

The *Australian Infrastructure Audit* is only the first step in our policy process to identify nationally significant reform and investment priorities to address the future needs of Australians. Over coming years, the Audit will inform the development of the *Australian Infrastructure Plan*, the *Infrastructure Priority List* and the *Australian Infrastructure Plan* progress report.

Our Audit, and its supporting or technical papers, offer a national evidence base that should act as a foundation for a discussion of Australia's current and future infrastructure needs and solutions. The Audit does not address all issues, however places emphasis on some of the most significant challenges and opportunities facing the nation.

We invite policy makers, financiers, infrastructure planners, construction workers and most importantly the people and businesses who use and rely on infrastructure for their daily needs to use the Audit as the basis for a public dialogue on infrastructure and to provide submissions for the development of the *Australian Infrastructure Plan* and *Infrastructure Priority List*.

Alongside this invitation, Infrastructure Australia will work intensively to reach out to communities, all levels of government and industry stakeholders in order to find gaps in our evidence and challenge or extend this report's findings. It is likely that some of our assessments and forecasts will be disputed. Infrastructure Australia welcomes this debate as a way of driving common understanding.





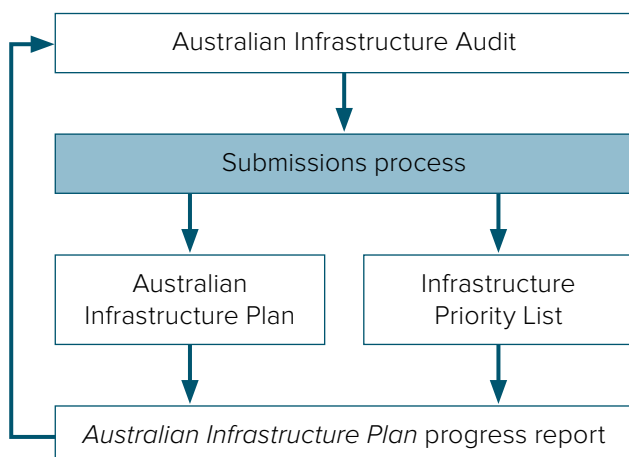


10.1 Our targets and priorities

Your feedback will guide our infrastructure decisions

Completing this Audit was the first step of Infrastructure Australia's program of work (Figure 1). We will next use the findings to build a package of recommended reform and investment priorities.

Figure 1: The Audit forms the basis of our work program



To set these priorities, we will work intensively for the next three months to engage with governments, community and industry. Your feedback will inform our work in developing two key documents:

- The *Australian Infrastructure Plan* will respond to each policy challenge and opportunity. It will give recommendations for reform and set a path for measuring progress.
- The *Infrastructure Priority List* will continue to evolve with new initiatives added to reflect nationally significant problems and opportunities that have been identified by the Audit. Existing Projects and Initiatives will, where relevant, link to the challenges and opportunities identified by the Audit, and Initiatives may be removed where the Audit findings do not support them.

Once a pathway for reform is set, we will use the *Australian Infrastructure Plan* progress report to track and publicly report on progress. This will inform a new set of challenges and opportunities for the next Audit.

Infrastructure Australia welcomes your input

To help us shape the future, we want to know what you think about this Audit.

For the next three months we will work intensively to engage with governments, community and industry. There will likely be differing views, and there may also be gaps in our evidence. We don't have all the answers, so we need your help to get this right.

To give feedback on our Audit, you can:

- **Make a submission** to tell us what we got right, what we missed, and what responses may be needed – such as policy reform or project investment. When you give this feedback, please respond directly to a relevant challenge or opportunity.
- **Provide new evidence**, if it is available and not reflected in the Audit. Please do this in a submission, or over time as evidence becomes available. Your contribution will ensure our evidence base stays as up to date as possible.

10.2 Your feedback

Anyone can make a submission

We encourage everyone to get involved from governments, industry experts and peak bodies, to academics, community groups and individual Australians. This is your chance to have a say on our infrastructure for the next 15 years and beyond.

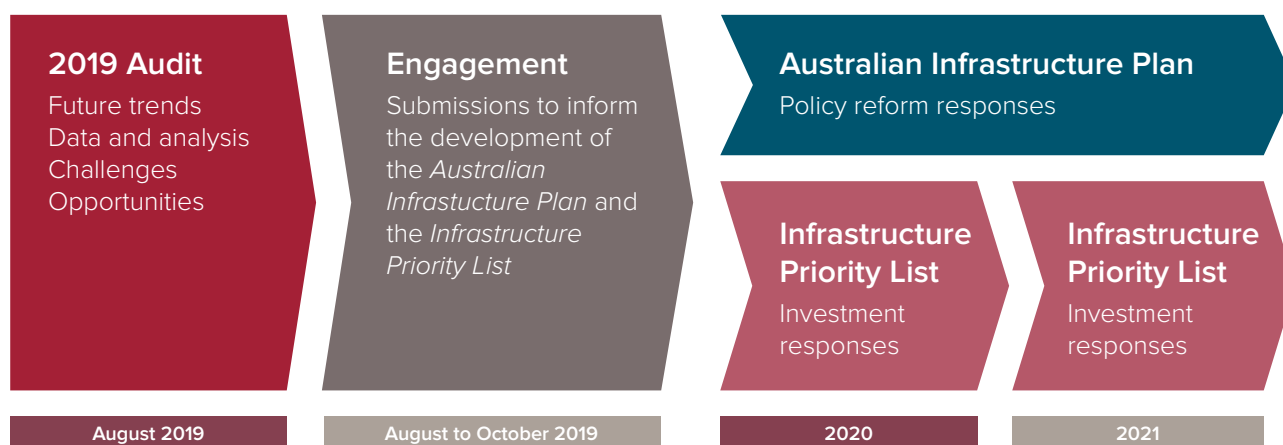
To comment on individual challenges and opportunities, or download a longer template with room for more supporting evidence, visit the Infrastructure Australia website:

www.infrastructureaustralia.gov.au.

If your submission includes a specific investment proposal, you should provide supporting documents through the separate *Infrastructure Priority List* submissions process, which closes on **31 August 2019** for this round. If you submit after this date, we will consider your submission in early 2021, along with the next *Australian Infrastructure Plan*. Figure 2 provides an overview of the submission process and indicative timings.

Your submission should identify which Audit challenges and opportunities each initiative or project responds to.

Figure 2: We invite submissions to help shape our future advice



Infrastructure Australia is an independent statutory body that is the key source of research and advice for governments, industry and the community on nationally significant infrastructure needs.

It leads reform on key issues including means of financing, delivering and operating infrastructure and how to better plan and utilise infrastructure networks.

Infrastructure Australia has responsibility to strategically audit Australia's nationally significant infrastructure, and develop 15 year rolling infrastructure plans that specify national and state level priorities.

www.infrastructureaustralia.gov.au

The bottom of the page features a large, abstract graphic composed of several overlapping geometric shapes. On the left, a large red shape extends from the bottom edge upwards. To its right, a dark blue shape overlaps the red one. Further right, a teal-colored shape overlaps the dark blue one. The shapes are arranged in a way that creates a sense of depth and modern design.