



Megatrends and the Victorian Environment

A report for the Victorian Commissioner
for Environmental Sustainability

November 2018

Glossary

Acronym	Full name
AEMO	Australian Energy Market Operator
ASX	Australian Stock Exchange
AV	Autonomous vehicle
BEV	Battery electric vehicle
CO2	Carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAE	Deloitte Access Economics
EPA	Environment Protection Authority
EV	Electric Vehicle
GPS	Global positioning technology
GSP	Gross State Product
HEV	Hybrid Electric Vehicle
IoT	Internet of things
OCES	Office of the Commissioner for Environmental Sustainability
PHEV	Plug-in Hybrid Electric Vehicle
PV	Photovoltaic

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Executive summary

Megatrends are significant shifts in environmental, economic and social conditions that will play out over the coming decades. They are altering the way industries, citizens and governments behave, and how they interact with the natural environment.

This report, commissioned by the Office of the Commissioner for Environmental Sustainability, explores five forthcoming megatrends influencing Victoria. We outline how these megatrends are impacting Victoria and its natural environment. These megatrends are anticipated to have a material and lasting impact on the Victorian economy and natural environment out to 2030 and beyond.

The five megatrends and their impacts on the Victorian environment are summarised below.

Megatrend	Impact on Victoria's environment
The physical impacts of climate change	With rising water threatening coastal environments, and more volatile weather conditions across the state, this megatrend will have a direct impact on the Victorian environment in many ways. Rising temperatures, reduced rainfall and increased frequency of extreme weather events will (among other things) contribute to a loss of biodiversity, lead to reduced water resources and increase instances of erosion.
Reducing our carbon footprint	In recent years, Victoria's efforts to mitigate the effects of climate change have fallen under the four pillars for emission reduction: increasing energy efficiency and productivity, promoting clean energy supply, electrifying the economy, and reducing non-energy emissions. By expanding the role of solar, wind, and hydroelectricity in the energy industry, Victoria's reliance on brown coal will diminish, resulting in a cleaner environment.
Clued-up citizens shaping business and government practices	Victoria's population is becoming increasingly educated, while in the digital age, information is becoming more accessible to citizens. This is allowing Victorians to better understand the impact of their decisions on the world around them through increased awareness of and concern for the environment. This is causing consumer preferences to shift towards sustainable, eco-friendly, and ethically-sourced goods, promoting sustainable investments, and improving waste recovery.
Disruptive technologies	Exponential growth in technology, such as artificial intelligence, automation, and quantum computing, will continue to disrupt consumer behaviour and Victorian industries. Technological improvements through the use of sensors could also lead to improved environmental management and monitoring. Generation of e-waste, however, will continue to be an environmental issue.
Natural resource constraints	With growing populations, demand for the natural resources needed to satisfy human needs will continue to grow. Through growing food demand and urban encroachment, land use will become more competitive, placing greater pressure on the natural environment. Water scarcity will grow as an issue in across the state, particularly in drought prone areas. Land clearing for agricultural and urban uses could cause further fragmentation to habitats and worsen the quality of land and soil across Victoria.

Introduction and background

About this report

Deloitte Access Economics was commissioned by the Office of the Commissioner for Environmental Sustainability (OCES) to outline anticipated high level environmental challenges and issues for Victoria out to 2030 and beyond. In order to assess these challenges, this report identifies and provides a narrative across five megatrends (defined as 'significant shifts in environmental, economic and social conditions that will play out over the coming decades') that are having a significant impact on Victoria; and in particular, its natural environment.¹

The megatrends outlined in this report are:

1. The physical impacts of climate change
2. Reducing our carbon footprint
3. Clued-up citizens shaping business and government practices
4. Disruptive technologies
5. Natural resource constraints

It is important to note some important limitations. Firstly, that this list of megatrends is not comprehensive, nor are the examples provided for each megatrend. It has been limited to those that are anticipated to have a material impact on Victoria's environment. Secondly, that inevitably there is some overlap between the themes identified for each megatrend. Megatrends are often inextricably linked, since they occur at the intersection of many smaller trends. Thirdly, this report contains future projections (e.g. climate projections, energy generation mix and electric vehicle usage), that come from a range of sources. This means that the projection periods vary, depending on the source.

The findings of this report are intended to provide context for OCES to consider future environmental issues and reporting priorities. Although this report is not a comprehensive study across environmental themes and issues, it is intended to help frame scientific assessments undertaken by the Commissioner in future years.

Background – about Victoria

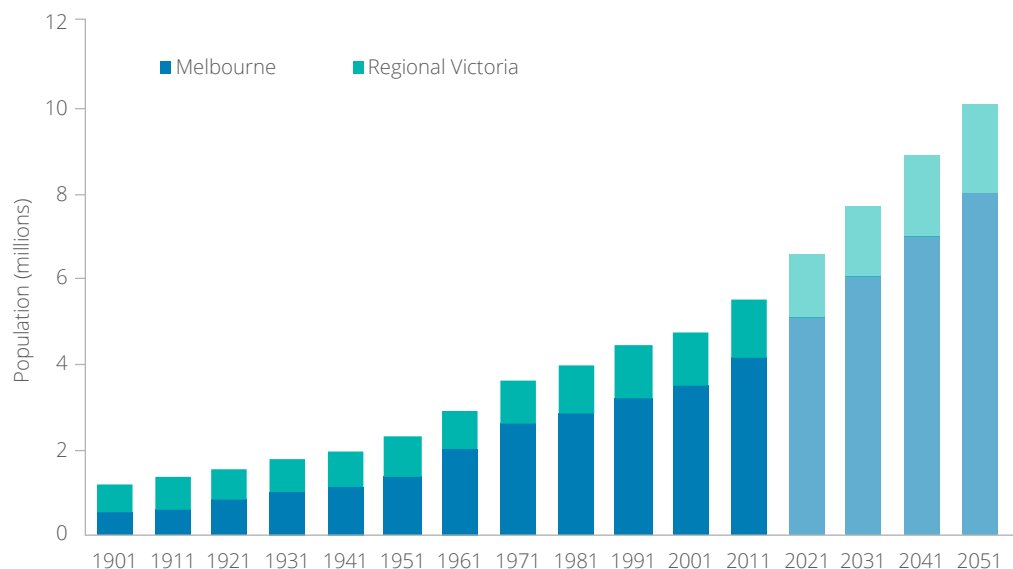
Prior to assessing these megatrends, it is important to establish a baseline of information for Victoria, to better understand the impact of these megatrends. Victoria's growing population and economy are important determinants of the human environmental footprint – in the subsections below we outline the current and future expected state of each of these.

Victoria's population

As at the end of 2017, Victoria had a population of 6.4 million citizens. During that year, Victoria's population grew by 143,400 citizens, or 2.3 percent, which was the highest growth of any Australian state or territory, both in proportional and relative terms. Home to more than 80 percent of Victoria's population, Melbourne has been the main driver of Victoria's population and economic growth.

Latest Victorian Government projections (Chart i) show that Victoria's population will grow at an average rate of approximately 1.5 percent per annum to almost 8 million citizens by 2031 and, to 10 million by 2051. Victoria's population growth has outpaced projections for much of the past decade, and with actual observed population growth of 2.3 percent in 2017, these projections appear relatively modest.

Chart i – Victorian historical and forecast population growth – 1901 to 2051



Sources: Department of Environment, Land, Water and Planning *Victoria in Future (2016)*, ABS *Australian Historical Population Statistics (2014)*

Regardless of projection accuracy, what is clear is that Victoria's population is likely to continue to grow, and as it does, so too will its ecological footprint.

Victoria's economy

With a Gross State Product (GSP) of almost \$399 billion in 2016–17, Victoria accounts for almost one-quarter of Australia's Gross Domestic Product (GDP), making it the second largest state economy.

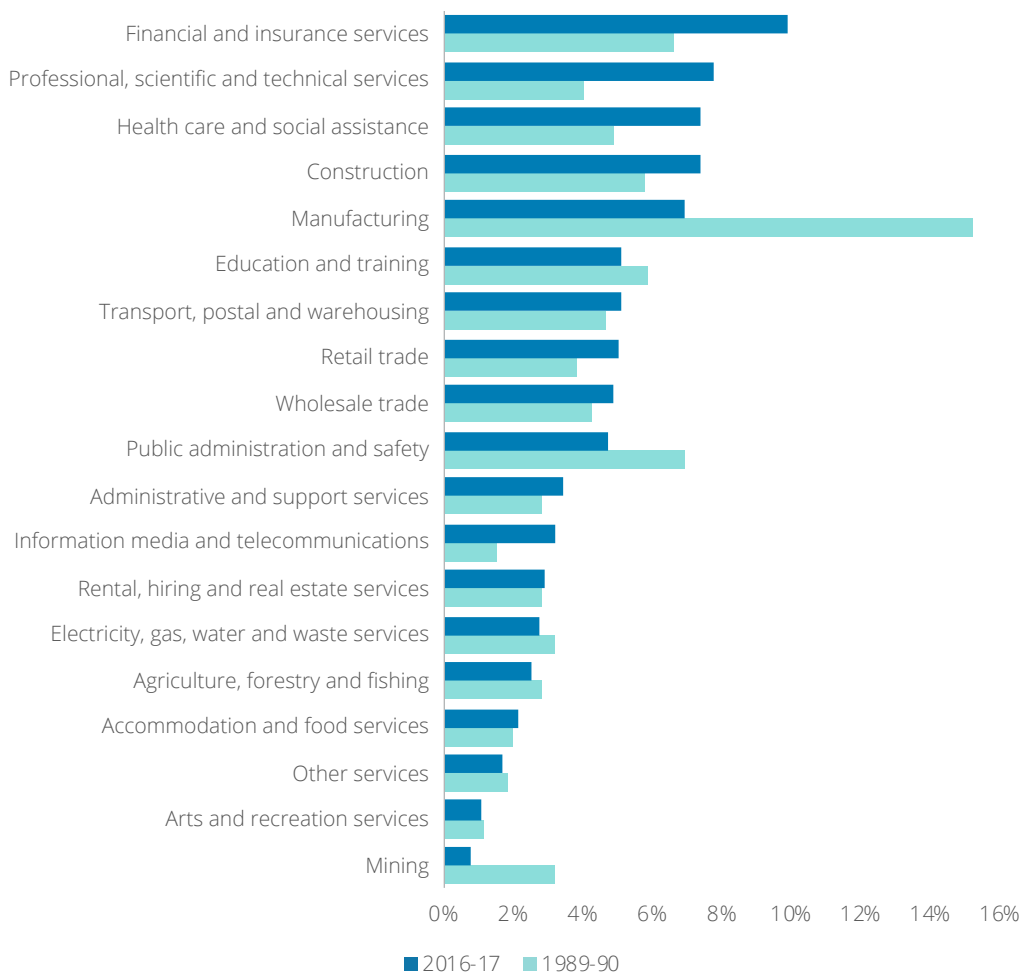
Whereas various other Australian states are rich in natural mineral resources, the Victorian economy has a greater reliance on knowledge-intensive industries. As such, the major sectors contributing to Victoria's GSP are services-based. Meanwhile, the state's strong population growth has underpinned a strong construction sector, increasing employment in construction trades.

This represents a major shift from the State's traditional status. Up until recently, the manufacturing sector dominated Victoria's economy, made competitive by a large, skilled blue-collar workforce and a strong coal-fired energy sector (Chart ii). However, major reforms to Australia's economy from the 1980s – including the privatisation of Government enterprises, the floating of the Australian Dollar, a shift towards freer trade and the formation of the Australia Stock Exchange (ASX) – has seen Victoria's economy evolve to become more integrated in the global economy.

As such, Victoria has shifted, and in some ways is continuing to shift, towards a services-based and more environmentally sustainable economy. Relative to 30 years ago, there are fewer major heavy industry and manufacturing sites. Recent years have seen the closure of sites such as the Ford and Toyota factories in Geelong and Altona, the Point Henry aluminium smelter and the Hazelwood coal-fired power plant. Meanwhile, investment and jobs are shifting towards lighter and advanced manufacturing industries (e.g. food and fibre, pharmaceutical products) and other industries (e.g. construction, renewable energy and transport technologies).²

However, in some ways, this decentralisation of industry also presents a challenge for environmental regulators – since there are growing numbers of smaller and often diffuse sources of pollution.³

Chart ii – Victorian Industry value-add expressed as a share of Gross State Product

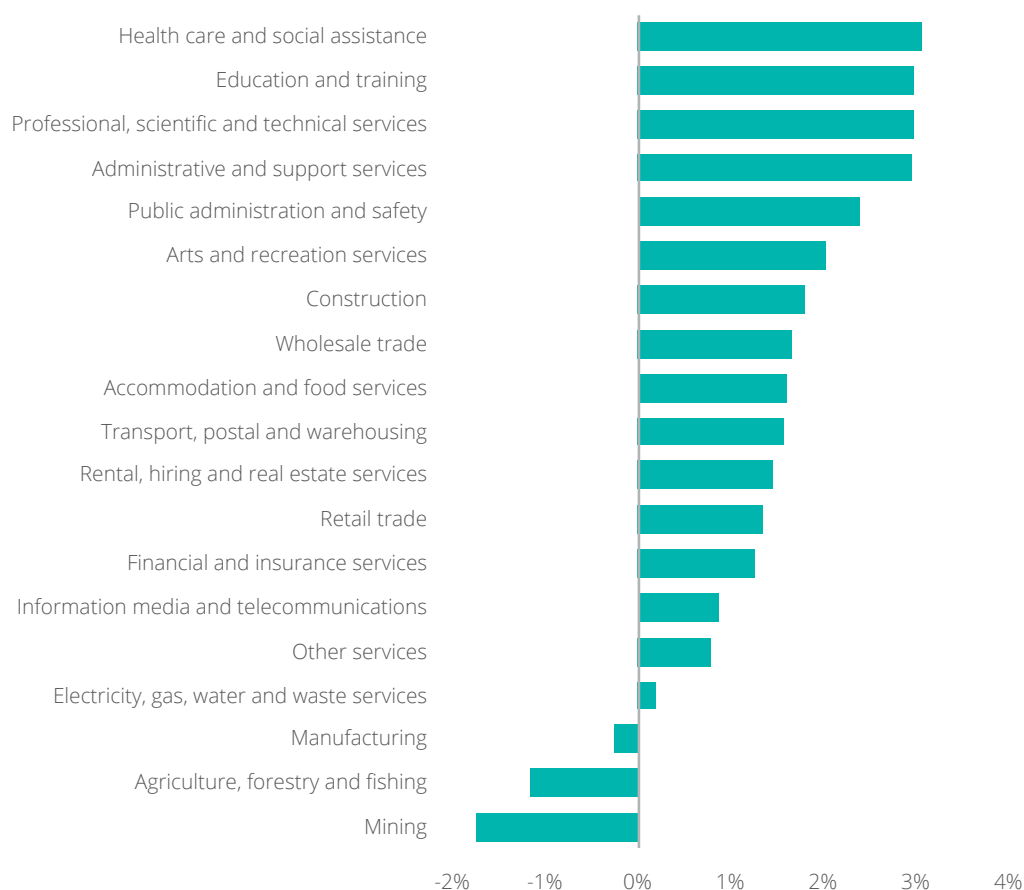


Source: Australian Bureau of Statistics, National Accounts: State Accounts

Looking forward, Deloitte Access Economics forecasts (chart iii) show that Victoria's services sector is likely to continue to be the engine room for growth. The five sectors with the highest forecast employment growth are all services-based.

Employment in manufacturing is forecast to continue to fall (as it has over the last 30 years). This is due to the continuation of two existing trends. Firstly, technological advancement should reduce labour input required in the manufacturing process. And secondly, a shift away from traditional heavy manufacturing sectors towards advanced and higher-value manufacturing sectors – such as food and fibre products, medical products and renewable energy technologies.

Chart iii – Forecast annual average employment change, Victoria (2018–2030)



Source: Deloitte Access Economics modelling

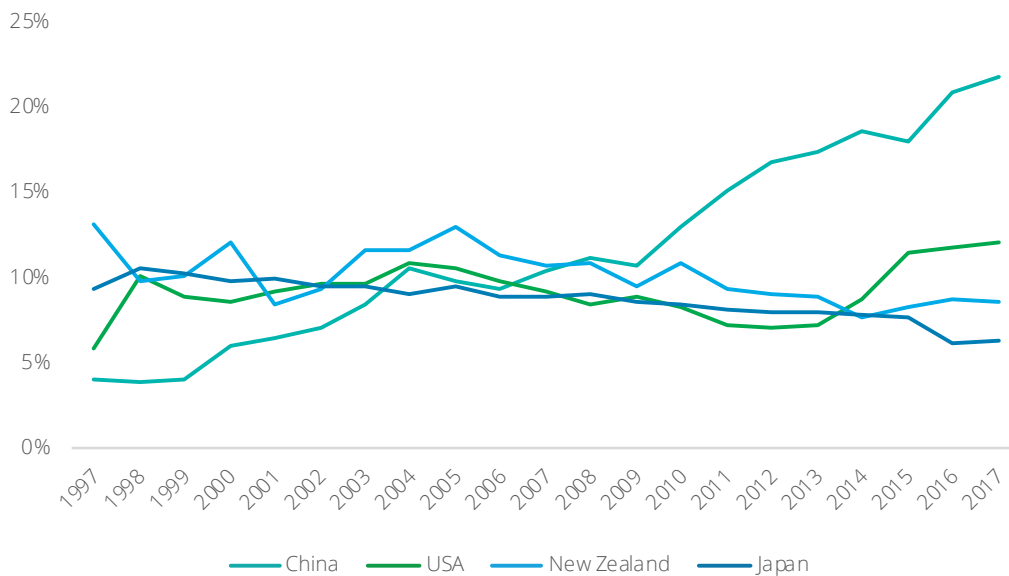
Global economic and political conditions are also shaping Victoria

Victoria's population and economy are not growing in a vacuum. Global economic and political forces have and will continue to influence Victoria's growth trajectory.

The balance of global economic power is shifting. Coming decades will likely see a shift in global power, typically, from traditional western economic powers to emerging economies across Asia, South America and Africa.⁴ Meanwhile, political sentiment in traditional economic powers is also shifting – seeing a return to trade protectionism and reduced multilateral collaboration on global issues such as climate change, poverty and terrorism. Among some economies, there is currently a backlash against globalisation. While this does not necessarily mean that it will be sent into reverse, it may disrupt the alliances and trade partners that traditionally defined Australia's place in the global economy, and have been a driver of Australia's export oriented economic growth.

The continued growth in Asian economies, particularly China, should continue to have a powerful influence on the Victorian economy. China's growth has seen incomes and purchasing power increase for a majority of its citizens, resulting in stronger demand for goods and services. This has been reflected in China's growing share of Victoria's exports (see chart below).

Chart iv – Share of Victoria's export revenue from goods, selected countries



Source: ABS International merchandise exports – Australia (Cat. no 5368.0)

This trend looks unlikely to reverse – and should eventually see up to two-thirds of the global middle class residing in Asia by 2030.⁵ This presents a significant opportunity for the Victorian economy to grow further. It is also likely to continue to underpin strong tourism and population growth in Victoria. This growing demand is, however, likely to place more strain on the environment and on our natural resources.

1. The physical effects of climate change

Climate change is one of humanity's greatest challenges. Globally, temperatures are rising and extreme weather events are becoming more frequent and severe.

Introduction: An emerging threat becomes a new reality

Climate change poses a significant threat to both natural and built environments. Research indicates that impacts will be widespread, with coastlines shifting as sea levels rise, and volatile weather patterns resulting in drought and floods. Extreme weather events will occur with increased incidence and severity. Rising temperatures could place strain on the biodiversity of our native flora, fauna, and marine life. By 2030, only twelve years away, the ocean will rise 7–18cm across most of the state's coastline.⁶ The combination of increased temperatures, wind, and longer stretches between rains will provide dangerous conditions across Victoria, with the potential for more furious bushfires than Victoria has ever experienced. Overall, Victoria will be prone to more extreme weather.

These factors could have profound impacts on the way Victorians organise and operate day-to-day life. Where, when and how we work might change. Victorians' expectations of government will increase. It is likely that Victorians' health will be affected – both directly (such as deaths and injury caused by serious weather events), and indirectly (floods affecting water quality)⁷. Our changing climate could start altering the demographics of employment; changing when, where, and how much work is available.

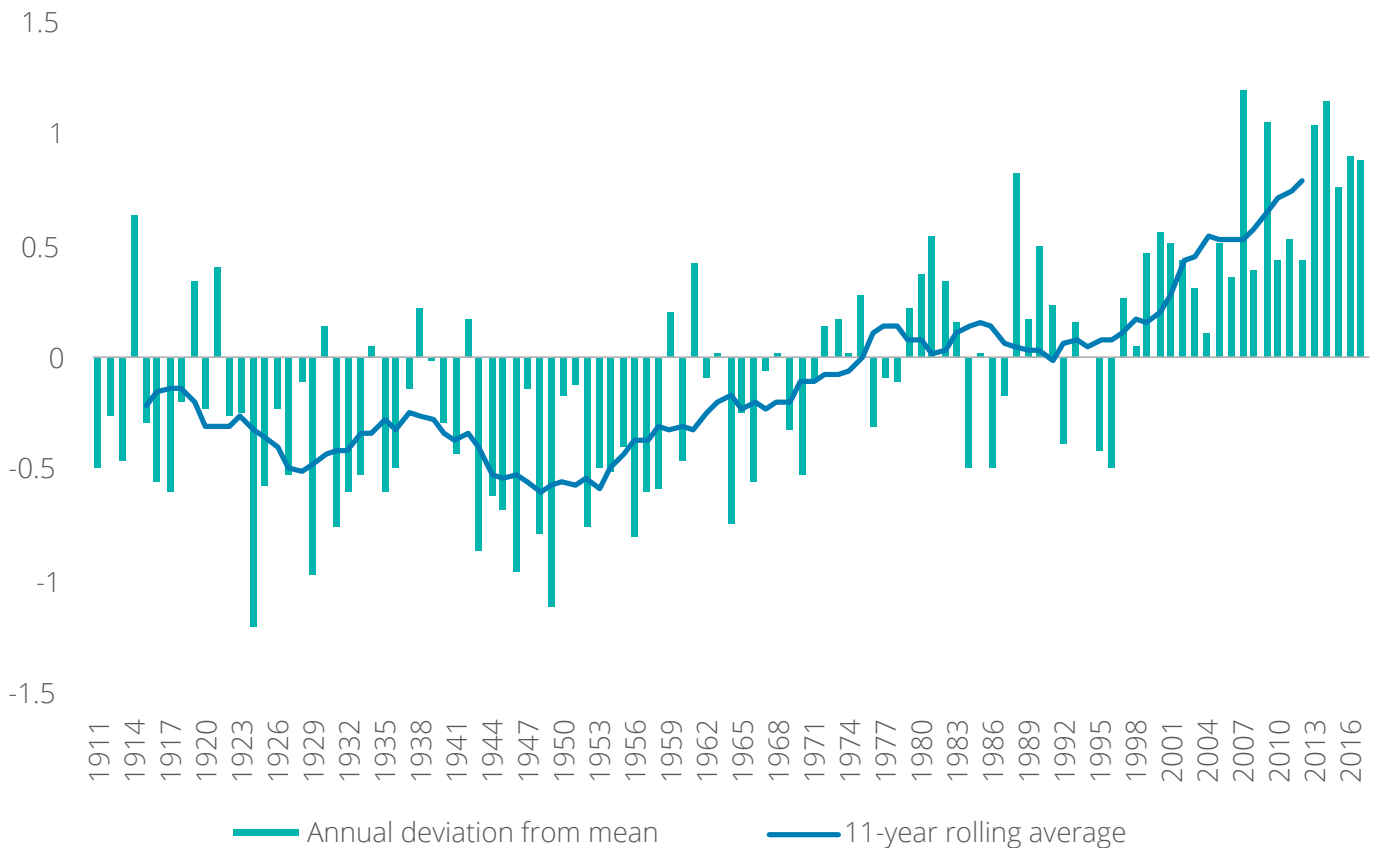
Although Victoria has a role to play in reducing anthropogenic emissions, and enabling technologies that support global transition, the biophysical changes Victoria experiences will be determined by the world's ability to reduce greenhouse gas concentration.

Globally there is a push to limit global warming to 1.5°C above pre-industrial levels, as the consequences of a global warming beyond this point are considered too high to readily accept, particularly for vulnerable regions and ecosystems.⁸ On the current trajectory global warming levels are expected to reach 1.5°C by 2030–2052.⁹

Even though much of this change to our climate is locked in for the short term, the long-term severity of climate change is sensitive to anthropogenic emissions. The diverging consequences of our ability to limit greenhouse gas concentration will only take effect later in the century. How we reduce our ecological footprint will be addressed in the following chapter.



Chart 1.1 – Victorian annual mean temperature anomaly (1911 to 2016)



Source: Bureau of Meteorology (2018)

How is this megatrend shaping Victoria?

Industry

Industries will likely have to climate-proof themselves, as best they can. Core service utility agencies, such as water, energy, and waste may need organisational assistance in planning for more extreme weather events. For example, Melbourne Water last year released its guidelines for planning for sea level rise, and the corresponding flooding risk.¹⁰ Climate risk analysis, mitigation and adaptation planning, all have a prominent part to play across all sectors, from education to infrastructure to healthcare.

Government

Similarly, it is likely that the expectations of all levels of government will increase. Citizens are looking at governments to decarbonise electricity, ensure large-scale fuel source switching, to reorganise and upgrade supply and transmission infrastructure, and help re-orientate end user consumption patterns. Extreme weather events such as fire and flooding could place increased burdens on Victorian service provision, with challenges felt most on the basic services the public are reliant on the government to provide, such as emergency management.

Local governments may become increasingly active and vocal. Being at the forefront in responding to the impacts of climate change, they are well positioned to inform higher levels of government about the on-the ground needs of local communities.¹¹ Nationally, almost one-in-five councils have set zero carbon, or 100 percent renewable energy targets.¹² 'Re-engineering' of public space could become more common, as part of a process of creating multiple environmental benefits from a singular public space. For examples, designing parks as floodwater basins, or using the relationship between existing and new infrastructure to prevent 'heat islands'.

According to a 2018 study, international cooperation will need to play a strong role in enabling the world to limit warming to 1.5°C by the end of the century, with global climate models relying on effective policy, such as global price on carbon, to incentivise transition.¹³ International relations may be strongly impacted by countries who fall out of step of the trajectory, leading to global conflict and deepening inequality.¹⁴

Victoria will need to respond to the global challenges posed by climate change. In particular, within South East Asia alone, 40 million people are projected to be displaced by climate change by 2050.¹⁵ The poorest and most vulnerable nations, including the Pacific island nations with low elevation, will see the greatest direct impact.¹⁶ An influx of climate refugees is not currently included in Victoria's population forecast, at levels greatly different than current net migration,¹⁷ leading to potential to disrupt Victoria's urban planning.

Health

Our changing climate could also have health consequences for Victorians. Heatwaves already cause more deaths than any other natural disaster. An increase in their frequency and severity could quite quickly cause an increase in deaths and illness, mainly cardiorespiratory. Vulnerable groups, such as the old, sick, young or socially isolated would need special assistance. One study found that if the state's health infrastructure and processes do not adapt by 2050, this may contribute to an extra 400 deaths per year in Melbourne.¹⁸ Warmer temperatures and new weather patterns could result in a rise in the risk of vector-borne and tropical weather diseases, especially as carriers spread southward, and to higher altitudes.

Increasing humidity in Southern Australia could also lead to hospitable conditions for carrier mosquitos, which will elevate the risks of contracting illnesses such as Dengue Fever, previously limited to tropical environments. The increased humidity, extreme heat and likelihood and duration of time spent in drought are all contributing factors to degradation of mental health.¹⁹

Interaction with water

Victoria's altering climate could also impact the way that humans interact with water bodies. Heat, and weather intensity, drive behaviours towards aquatic activity to stay cool. Longer summer periods increase pressure on lifesaving services and coastal/water based infrastructure – the same infrastructure at high risk of flooding and erosion. As demand grows and the options available decrease, recreational options available to Victorians could come under increasing pressure. Negative effects on marine life would likely correspond with negative effects on tourism and water-based biodiversity. More damaging storm surges and higher wave heights also pose a danger to humans.

How will this megatrend impact Victoria's environment?

Rising coastal water

CSIRO projections indicate that, by 2030, the ocean will rise between 7 and 18cm (relative to the 1986–2005 level) across most of Victoria's coastline,²⁰ and that this increase is locked in, regardless of action taken to constrain carbon emissions. Along our coasts, we will see higher storm surges, with inundation of low-lying, inter-tidal areas becoming more frequent. Our sandy shorelines, cliffs and foreshores will recede,²¹ meaning that we could lose natural coastal defence, making previously untouched ecosystems

more vulnerable. The changing locations, frequency, and intensity of storms will increase swell height, set-up, and run-up.²² Damage to coastal infrastructure will worsen. Increased sewer overflows and coastal flooding of populated areas will result in a higher risk of pollution in our waterways.

Periodic flooding will increase, whilst mean rainfall will reduce

Periodic flooding is going to increase, as extreme rainfalls gain intensity. A poleward shift in storm tracks would cause precipitation conditions traditionally experienced in tropical areas to gradually move towards New South Wales and Victoria, with the warmer atmosphere bringing about both increased intensity and frequency of maximum daily rainfall.²³ Increasing intensity of rain and floods will effect marine life, as surface water salinity, pollutant, sediment and nutrient profiles fluctuate.²⁴ Meanwhile, seasonal and mean annual rainfall is projected to decline. This projection is most pronounced in the cooler months, with some climate models pointing to increases in rainfall over summer.²⁵ However, future projections for water resources are subject to a high range of variability, and the outcome of future rainfall on our water resources cannot be projected with a high level of confidence. Stream flow is also difficult to project. Although rainfall is the primary driver of streamflow, there are many complex and potentially compounding impacts including fires and drought.

Drought events will become more frequent

Warmer conditions, and a steady increase in water demand point to drought. In a 2°C warmer Australia (which is more likely to occur toward the end of the century, rather than the more immediate future), one study predicted that there is a 74 percent chance of an equivalent to the 2006 drought, every year.²⁶ Correspondingly, longer and more dangerous fire seasons, poses a greater risk to human life. Drought severity will be made worse with the rainfall and flooding changes mentioned above.

Biodiversity

Victoria's biodiversity is likely to be negatively affected, with changing conditions taking a toll on native flora and fauna. Species living in their upper temperature ranges (e.g. alpine species), or those that are in restricted climatic niches face the greatest level of threat to their ecosystems. Climate change is causing both migration and species extinction, with 47 percent of global extinctions reported in the 20th century possibly caused by climate change.²⁷ Geographical ranges of plant and animal species, on both land and water, have

shifted approximately 17km poleward per decade, over the last several decades.²⁸ These changes to our climate could also place stress on insect populations, with an impact on pollination ranges, leading to potentially dire consequences for biodiversity and the function of ecosystems.²⁹ Action would be required to ensure that there is enough remnant habitat, invasive species are controlled, and that dispersed habitats do not become isolated from one another.



2. Reducing our carbon footprint

As the anthropological drivers of climate change become more apparent, industries and governments are changing existing practices and policies to reduce their carbon footprint.

Moving towards a net-zero-carbon economy

In recent years, climate change mitigation through reducing greenhouse gas emissions has emerged as a major international policy issue. In 2015, Parties to the UN Framework Convention on Climate Change reached a landmark agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future.

The Paris Agreement set in place a durable and dynamic framework for all countries to take climate action from 2020, building on existing international efforts in the period up to 2020, including:

- A global goal to hold average temperature increase to well below 2°C and pursue efforts to keep warming below 1.5°C above pre-industrial levels.
- All countries to set mitigation targets from 2020 and review targets every five years to build ambition over time, informed by a global stocktake.
- Robust transparency and accountability rules to provide confidence in countries' actions and track progress towards targets.
- Promoting action to adapt and build resilience to climate impacts.
- Support to help developing countries implement the Agreement.

In Australia, policies and initiatives to reduce carbon emissions and transition towards renewable energy sources have evolved over recent years.

At the federal level, a carbon tax was implemented in 2012 but was repealed in 2014. Current policies reflect a preference for incentivising businesses to reduce or offset emissions and encouraging households to switch to renewable energy, rather than a broader incentive scheme such as pricing or capping carbon emissions.

Victoria appears well positioned to prosper as the world transitions to a net-zero-carbon economy, primarily through our abundant wind and solar potential.³⁰ New industries are expected to emerge, as Victoria gets smarter with the production, usage and storage of clean fuels and energy sources.

Over the next 30 years, our methods of transport are also likely to change. Although timelines remain uncertain, automated and/or zero-emissions vehicles are expected to move from the concept/design phase, into mainstream adoption. This could give rise to a raft of new policy and infrastructure challenges for government. The way that Victorians move themselves and their resources is ripe for change in the next 30 years. Reliance on public transport infrastructure will continue to grow, and carbon-emitting vehicles could make way for zero carbon, often shared, vehicles.

In 2015, The Victorian Government outlined its four pillars of emission reductions:³¹

- Increased energy efficiency and productivity
- A clean energy supply
- Electrifying the economy, and switching to clean fuels
- Reducing non-energy emissions, and an increase in carbon storage.

How is this megatrend shaping Victoria?

Future of energy generation

Like many advanced economies around the world, Victoria is currently undergoing a significant transition away from traditional, coal-powered energy towards renewable sources. This transition will be key to reducing greenhouse gas emissions. In June 2016, the Victorian Government committed to Victorian renewable energy generation targets of 25 percent by 2020 and 40 percent by 2025.³² The Victorian Renewable Energy Auction Scheme supports this target – in September 2018, the Government conducted its first auction, investing in projects that will generate over 900 megawatts of wind and solar energy.³³

Victoria currently generates electricity through a range of renewable sources:

- **Solar** panels in homes and small businesses have already caused a shift in energy generation in Victoria. The number of houses and businesses that have installed small-scale solar panels in Victoria has grown significantly in a relatively short period, with 340,000 solar power systems installed in Victoria alone.³⁴ In Australian Energy Market Operator (AEMO)'s strong growth scenario (High DER Uptake) rooftop solar is projected to provide up to 34 percent of Victoria's energy demand by 2039–40.³⁵
- **Wind** was Victoria's largest renewable energy source in 2016–17, accounting for 7 percent of total energy generated and 55 percent of all renewable energy generated. This share will likely grow considerably out to 2030. Based on the current list of proposed, approved and under-construction windfarms,³⁶ Victoria's wind energy generation is set to more than triple from 1,733 MW to 5,627 MW.
- **Hydroelectricity** accounted for 2 percent of electricity generated in Victoria in 2016–17 and varies annually with water availability.

Victoria's hydroelectric potential is largely developed, leaving limited potential for future growth.³⁷

- **Bioenergy**, which utilises wood and wood waste from the pulp and paper industry accounted for 1 percent of electricity generated in Victoria in 2014. Deloitte Access Economics expects this sector to expand in the coming decades.

There has yet to be significant investment in large-scale **marine power generation** in Victoria, however the Australian Government has announced funding for a pre-commercial demonstration in Portland. Marine power is unlikely to contribute significantly to energy generation in the short to medium term. **Geothermal** exploration has begun in the Otway Basin, but is still in its early stages. While it is not expected to contribute significantly to Victoria's electricity supply in the near future, it has the potential to become a source of consistent power from a renewable resource.

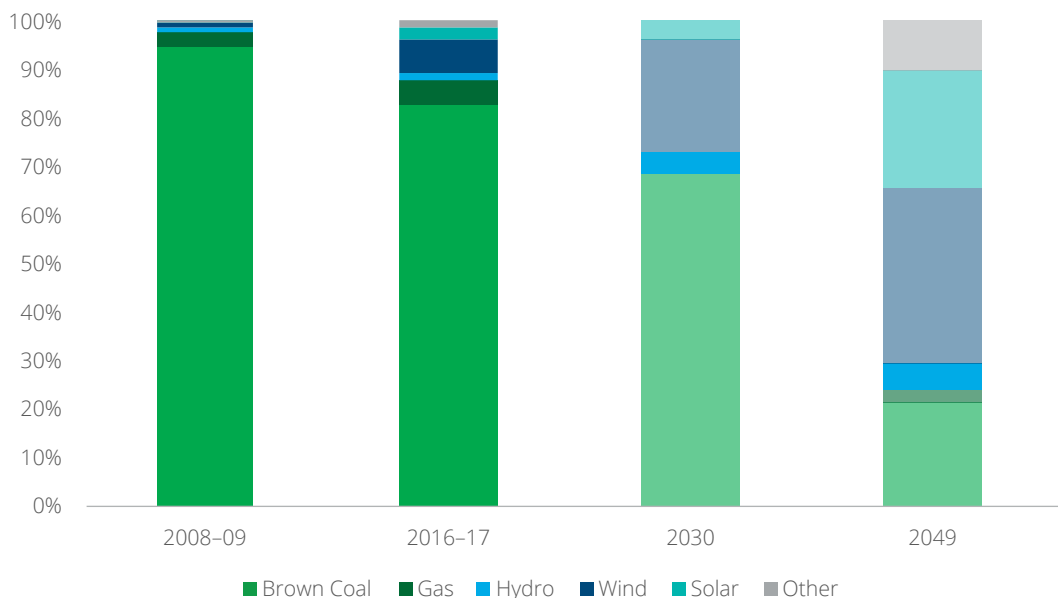
Deloitte Access Economics has projected electricity generation for Victoria out to 2049–50 (Chart 2.1). This scenario assumes that the electricity sector

contributes proportionally to Australia's Paris agreement commitments (i.e. 26–28 percent reduction on 2005 levels), and that the Victorian Renewable Energy Target is met by 2025.

According to these projections, brown coal (which currently accounts around 80 percent of Victoria's electricity) would account for 68 percent of Victorian generation by 2030 and 21 percent in 2049. Victoria's major sources of renewable energy are projected to be wind (23 percent in 2030, 36 percent in 2049), solar (4 percent/24 percent) and bioenergy (0 percent/11 percent).

Gas is projected to account for 2 percent of Victoria's energy generation in 2049. While not a renewable energy source, gas has a significantly lower greenhouse gas footprint, and causes less air pollution, than brown coal.³⁸ However, there are three likely decarbonisation pathways for Victorian gas: biogas production, hydrogen and carbon capture and storage.³⁹ The next 5–20 years will likely see the introduction and creation of pilot programs, moving into their adoption in Australia's gas networks.

Chart 2.1 – Electricity generation in Victoria, by fuel type



Source: Deloitte Access Economics modelling (Note: translucent bars represent forecasts)

Future of energy distribution – smart grids and off-grid systems

In order to integrate energy from intermittent and unpredictable renewable energy sources, new technology is required to allow bi-direction communication between energy retailers, distributors, and customers. Smart grids bring computer technology to standard electrical grids, allowing the integration of renewable energies while reducing and shortening power outages and allowing consumers to analyse and manage their energy use.

At the household and small business level, off-grid power generation systems coupled with battery storage are becoming more commonplace and should continue to do so as battery costs fall. Old car batteries from electric vehicles could be repurposed in future and store energy for households with solar panels – which would accelerate growth of in-home storage systems. Installation of residential energy storage systems (batteries) exceeded 20,000 in 2017, up from less than 1,000 in 2015.⁴⁰ Meanwhile, a large scale battery installed

in South Australia has improved grid stability by dealing with small, regular frequency variations and major power disturbances.⁴¹ At least two similar, although slightly smaller, batteries are being installed in Victoria.

Similarly, energy storage coupled with localised solar/wind generation could enable micro grids (or mini grids) – where homes store and share renewable energy with one another through power lines.⁴²

Zero emissions transport

The two mostly likely fuel sources to replace traditional fossil fuels for widespread passenger and commercial vehicle use are electricity and hydrogen. Both of these technologies have significant potential to reduce Victoria's greenhouse gas emissions and considerably improve air quality.

Electric vehicles

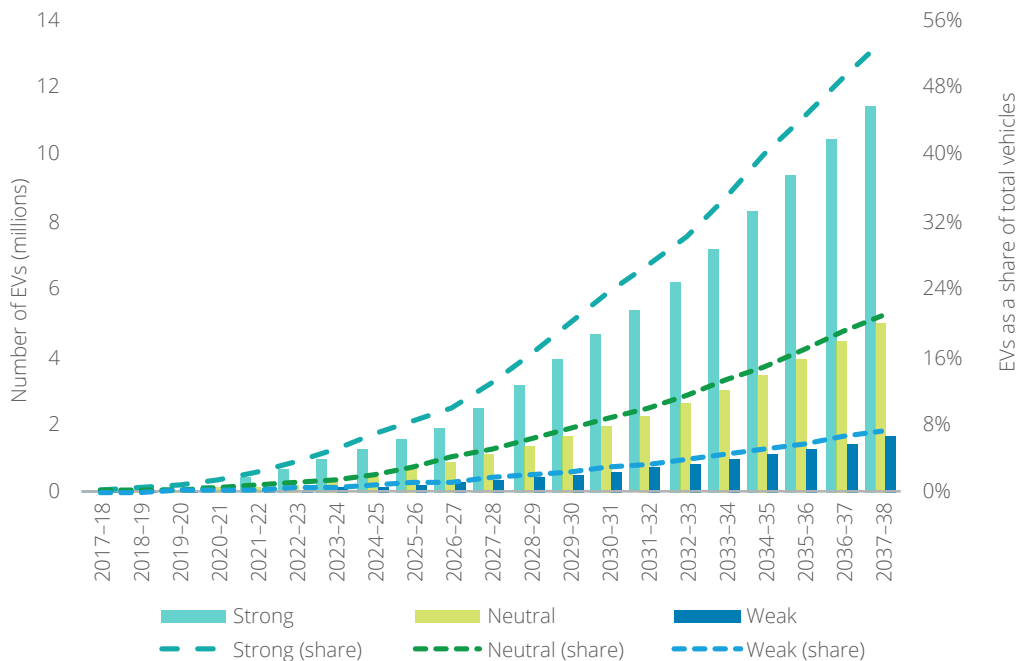
Currently, there are three categories of electric vehicles on the market, classified according to the amount of electricity that is used as the energy source:

- Hybrid Electric Vehicles (HEV) – with both an electric motor and petrol engine that work in unison to power the vehicle.
- Plug-in Hybrid Electric Vehicles (PHEV) – powered by both an electric and petrol engine with the capacity to regenerate power while driving and through a plug-in charging outlet.
- Battery Electric Vehicles (BEV) – vehicles with an electric motor and a battery that is charged during use and an external charging outlet.

The Department of the Environment and Energy has assumed (in its Emissions Projections 2017) that the price of BEVs will decline to a price parity by 2025 with traditional internal combustion engines vehicles.⁴³ Projections by the AEMO forecast three different scenarios of electric vehicle uptake. Under the 'strong' scenario, where uptake of EVs is strongest, AEMO estimates that the number of EVs will grow to around 4 million in 2030, and to 11.4 million in 2037–38, representing 53 percent of Australia's total.



Chart 2.2 – Forecast for Electric Vehicles in Australia, absolute number and share of vehicles



Source: AEMO 2018 Integrated System Plan Assumptions

Hydrogen vehicles

Hydrogen fuel cell vehicles use hydrogen gas to power an electric motor. While emissions are reduced from the use of these types of vehicles (relative to fossil-fuels), there are currently emissions associated with hydrogen production. Further development is required in the hydrogen supply chain to support hydrogen fuel cell vehicles, with only limited investment in hydrogen production and refuelling stations in Australia. Importantly, the sector has identified hydrogen supply and lack of supporting infrastructure with The National Hydrogen Roadmap providing the pathways to an economically sustainable hydrogen industry in Australia.⁴⁴ An opportunity exists for Australia to become a major hydrogen exporter for countries seeking to reduce emissions in a cost-effective manner. Hydrogen could grow to become a multibillion dollar export opportunity in Australia, according to a panel of energy, technology and policy leaders and chaired by Australian Chief Scientist Dr Alan Finkel.⁴⁵

Fossil-fuel phase out

A transition towards electric and/or hydrogen-powered vehicles may coincide with a phase-out of petrol and, more imminently, diesel vehicles. Globally, governments and major car manufacturers (such Toyota⁴⁶ and Nissan⁴⁷) have announced their intentions to phase out the sale and/or use of diesel engines. Mayors of cities such as Paris, Athens, Mexico City and Madrid have announced plans to ban diesel cars and vans from the roads by 2025. European nations have strongly supported this transition, with Scotland (2032), the UK (2040), France (2040), Norway (2025) and the Netherlands (2030) all setting targets to phase out diesel and petrol vehicles.⁴⁸ While the Australian Government is yet to make such an announcement, this global trend should drive down both the supply of and demand for conventional vehicles.

The marketisation of carbon, addressed further in the chapter, would heavily incentivise the decarbonisation of industry; especially carbon-intensive energy generation in Victoria.

How will this impact the Victorian environment?

- A move toward renewable energy, and zero emissions transport, should reduce the volume of brown coal burnt, resulting in cleaner air and less GHGs in the atmosphere. This is particularly relevant for the Latrobe Valley – where power generation accounts for a significant proportion of fine particle emissions in the region. The Hazelwood coal mine fire in 2014 was one of the state's major pollution events, sending smoke and ash over Morwell and surrounding areas.⁴⁹
- Increasing electrification would mean that emissions pathways, and their corresponding impact on the environment, would be heavily dependent on uptake of renewable energy sources.
- The increase in localised power may reduce the resource necessity of growing and maintaining a heavily centralised energy system. This could reduce resources dedicated to energy transition, including land and natural resources.
- Pollutants released into the environment by fossil-fuel powered vehicles should also fall as cleaner vehicle technologies become widely adopted.

3. Clued-up citizens shaping business and government practices

The growing awareness and expectations of informed citizens will shape business and government practices, and ultimately Victoria's environment.

The informed citizen

As economies grow and its citizens become wealthier, more and more people have access to education, in its many forms. Concurrently, in the digital age, information is more accessible, meaning that people have more information readily available, allowing them to understand how their decisions are impacting on the world around them.

As a result of this improved access to information, the ecological and social implications of consumer purchase decisions are becoming more broadly understood, whether those implications are environmental (such as reducing food wastage or disposable plastic) or ethical (such as animal welfare standards or worker conditions). Consumers are becoming increasingly 'clued-up', and they increasingly care about the impacts of their consumer decisions.

Initiatives across all levels of government, industry and households are collectively attempting to reduce the carbon footprint of the Victorian economy, recover a greater share of our growing waste, conserve habitats that support biodiversity and improve air and water quality.

Education trends

Victorian education attainment rates have improved in recent years. Over 75 percent of Victorians aged 20–29 have completed year 12 or equivalent, compared with 45 percent of Victorians aged 40 and over.⁵⁰

Tertiary education attainment amongst Victorians mirrored this trend, with 40 percent of Victorians aged 25–39 having attained a Bachelor Degree or higher, compared with 24 percent across the population. This attainment rate is projected to grow to over 28 percent in 2025.⁵¹ Meanwhile, our economy relies on strong education, with education services in 2016–17 accounting for 5.5 percent of total Victorian household expenditure, up from 3.5 percent in 2000–01.⁵²

Education attainment has been linked with increased awareness and concern for the environment.⁵³ Continued growth in education attainment should therefore spell positive outcomes for the environment.

Models of education are being disrupted. Victoria – with its large education sector, has a lot to lose or gain. With a new generation of tech savvy students moving through the education system, who are able to connect globally with the touch of a button, it makes sense that more education is moving online – making it more affordable and accessible for more of the population.⁵⁴ This trend is likely to continue as technology, and connectivity, become more commonplace across the country, supporting the growing number of clued-up consumers.

Knowledge on-demand

Formal education is not the only driver of this trend. The rise of the internet and digital media is allowing people to form new connections and selectively access information through multiple channels,

which is leading to changed societal behaviours with both positive and negative outcomes.

On the positive side, it is enabling a greater share of the population to research and educate themselves about a topic or issue in a fraction of the time and effort that it once took. On the negative side, increased access to information has also eroded trust in traditional information sources.⁵⁵

How is this megatrend shaping Victoria?

Consumption patterns are changing

Armed with more information, consumers are increasingly demonstrating a preference for sustainable, eco-friendly and ethically-sourced goods. An example of this megatrend at work is caged eggs. In 2009, caged eggs represented nearly 70 percent of the market, whereas by 2017, this share had fallen to 49 percent.⁵⁶ Demand has shifted based on a shift in consumer ethics or values – inducing a response from egg producers.

Consumers are increasingly factoring in environmental concerns into their consumption.⁵⁷ Recent estimates from Nielson suggest that 64 percent of Asia Pacific consumers are willing to reach deeper into their wallets to support socially conscious brands – with millennials leading the charge.

Environmental concerns will likely escalate as the impact of climate change becomes more apparent.

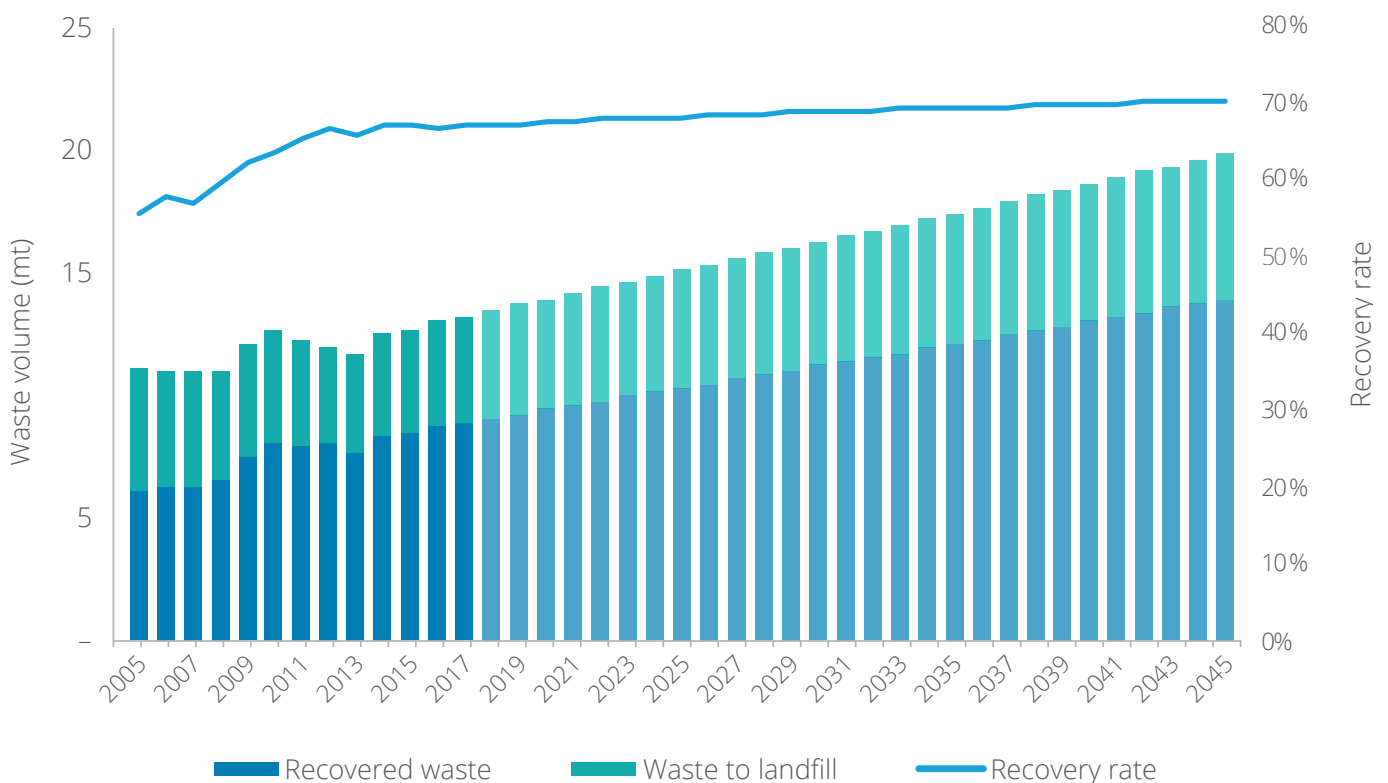
A recent survey showed that 73 percent of Victorians prefer to buy from businesses that show they care about climate change, while growing citizen awareness is increasing the expectations placed on governments to promote sustainable practices, to preserve natural resources and protect important heritage assets.⁵⁸

Victoria's growing population comes at a cost to our environment as our total waste is projected to rise by 2.8 million tonnes, reaching 16.2 million tonnes by 2030.⁵⁹

Chart 3.1 (below) illustrates the expected trajectory of Victoria's waste and highlights that while our total waste is expected to rise, so too should the waste recovery rate. Victorians' understanding and appreciation of the importance of waste recovery should continue to grow, ensuring improved waste recovery by households and increasing pressure on businesses and governments to follow suit.

Shifting consumer preferences are driving new and innovative business practices, focussed on improving social outcomes and making a measurable contribution to addressing global environmental concerns.

Chart 3.1 – Victorian waste generation



Source: Sustainability Victoria, Waste Data Portal

Investment decisions are influencing corporate accountability

Just as consumer expectations are shifting, so too are investor expectations surrounding sustainability. Traditional annual reports, which exclusively focus on how firms manage financial capital, no longer suffice in a world where stakeholders demand information regarding the impact of an organisation

on communities and the environment. Armed with a range of sustainability reporting frameworks, including Global Reporting Initiative (the most popular framework for ASX companies), it is now commonplace for businesses to publish sustainability reports. Amongst ASX200 companies, those that produced medium-to-high quality sustainability reports attracted 83 percent of capital investment in 2018.⁶⁰

B-corporation certifications, introduced in 2013, use stringent criteria to independently acknowledge innovative sustainable business models that render a positive contribution towards addressing pressing social and environmental concerns. Today, Australia has over 220 certified firms generating over \$1 billion in revenue.⁶¹

Reporting plays a large role in reducing the cost of capital for listed companies, but it also enables investors and consumers to be better informed in the strategic priorities of these companies. Superannuation funds and asset managers are increasingly presenting sustainable investment products to their account holders. In 2018, the Australian Superannuation system holds \$2.6 trillion in net assets – a figure which is projected to grow to as much as \$9.5 trillion by 2035.⁶² The growing buying power of these funds means that they have the potential to drive social and environmental change.⁶³

The role of Government will continue to evolve

Government policy can continue to play a key role in steering engaged consumers and business towards sustainable decisions, by providing signals, information and resources to support a more sustainable lifestyle. Governments' ability to monitor and manage impacts on the environment will only improve with technological innovations.⁶⁴

Government organisations are embracing technology by disseminating research, targeted at educating and persuading businesses and individuals to make environmentally conscious decisions. Some policies at the forefront of shifting Victoria's consumption patterns towards more sustainable decisions include the Take2 pledge, G05 and Love Food Hate Waste campaign. These initiatives require measures to monitor their effectiveness.

Meanwhile, Governments are likely to continue to develop and improve environmental reporting measures. In 2018, the Australian Bureau of Statistics introduced the Australian Environmental-Economic Accounts – an international statistical standard consistent with the System of National Accounts. This system of accounts will allow Australians to assess overall natural resource efficiency,

by measuring economic growth against resource use and other environmental indicators (energy, water, greenhouse gas emissions).⁶⁵ These accounts may also enable governments to better understand the value of environment projects when assessing their suitability for funding against, for example, infrastructure projects.

Sustainable choices will improve environmental outcomes

The Victorian environment should benefit directly from a reduction in emissions driven by these trends. In particular, engaged consumers, business and government bodies in Victoria are predicted to contribute to a 1.3 percent reduction in Victoria's total greenhouse gas emissions.⁶⁶ The growing superannuation buying power could also support this reduction, as sustainable portfolio options provide consumers with the choice to divest from fossil fuels.

As informed consumers demand more ethical, sustainable products, supply chains may need to respond with a more sustainable approach, reducing emissions, and showing more sustainable approaches to resource management.

Citizen science

Globally, clued-up citizens are increasingly participating in citizen science projects. Citizen science involves "public participation and collaboration in scientific research, with the aim to increase scientific knowledge."⁶⁷ While citizen science is not a new phenomenon – the first citizen-run bird census occurred on Christmas day in 1900 – it has gained increased popularity globally over the past two decades.⁶⁸ This can be attributed to the following:

- **People are living longer**, meaning that there is a large and often skilled cohort of retired people looking to put their skills and knowledge to use, and time to participate.

- **Scientists and governments are realising the benefits of engaging volunteers**, particularly where the geographic or temporal scale of the project is large.
- **Technological advancement**, most notably the widespread adoption of personal computers, and more recently smart phones and tablets – has unlocked the potential of citizen science and sped up the collection of data from citizen scientists.⁶⁹

One example is the Victorian Environment Protection Authority (EPA) established a Citizen Science program in 2014, which has engaged with over 100 citizen scientists across a range of projects.⁷⁰ Based on the trends in citizen science observed globally, it is likely that programs such as these will become more commonplace in future.

Our tourism footprint is growing

Relative to population and income growth, advanced economies around the world are experiencing a fall in material consumption. Wealthier, more educated societies, where basic material needs are met, demonstrate a preferential shift towards experiential services, meaning they allocate more of their income towards activities such as tourism, education and entertainment.⁷¹

Victoria's visitor economy is growing – driven by increasing numbers of international and domestic visitors. In the year ending March 2018, Victoria had 3 million overnight visitors (up 9 percent year-on-year) while the number of domestic overnight visitors grew by 6.6 percent to 24 million.

Sustainable tourism, or ecotourism, is an emerging subsector in Victoria. This mode of travel provides tourists with a natural experience that fosters a connection with the land, whilst promoting cultural understanding and appreciation.⁷²

How will this megatrend impact the Victorian environment?

- Education levels drive concern for the environment, and education attainment levels are continuing to grow in Victoria. Demand for sustainable business practices and government policy is likely to increase accordingly.
- A spotlight on investor behaviour could result in more sustainable investment decisions, especially in power generation, leading to cleaner air, and lower carbon emissions.
- Waste recovery systems will likely improve. Households are likely to shift towards more sustainable waste management practices, while consumers are placing greater pressure on businesses to take steps to reduce waste. This should reduce the pressure on Victoria's landfills.
- As visitation grows, there are likely to be

greater negative environmental impacts of higher visitation – particularly in natural attraction areas such as the Great Ocean Road, alpine areas, the Dandenong Ranges, the Murray River and the Grampians national park. Demand for infrastructure will grow – such as accommodation, amenities, walking trails, which could encroach on natural reserves over time. This trend, however, may be at least partially offset by greater demand for ecotourism.

- The combination of government policy and education, along with more environmentally conscious consumers are also expected to drive the production and consumption of eco-friendly and sustainable goods. These economic decisions will positively influence Victoria's environment through healthier soils, more water resources, enhanced biodiversity, and reduced carbon emissions.⁷³

- More indirectly – our increasing education levels could continue to see a shift towards a knowledge-based economy in Victoria. This would reduce the environmental strain caused by heavy industry, including chemical use, water and soil health. New industries and businesses, could have to meet higher environmental standards, not only to comply with government regulations, but also to meet consumer demands.



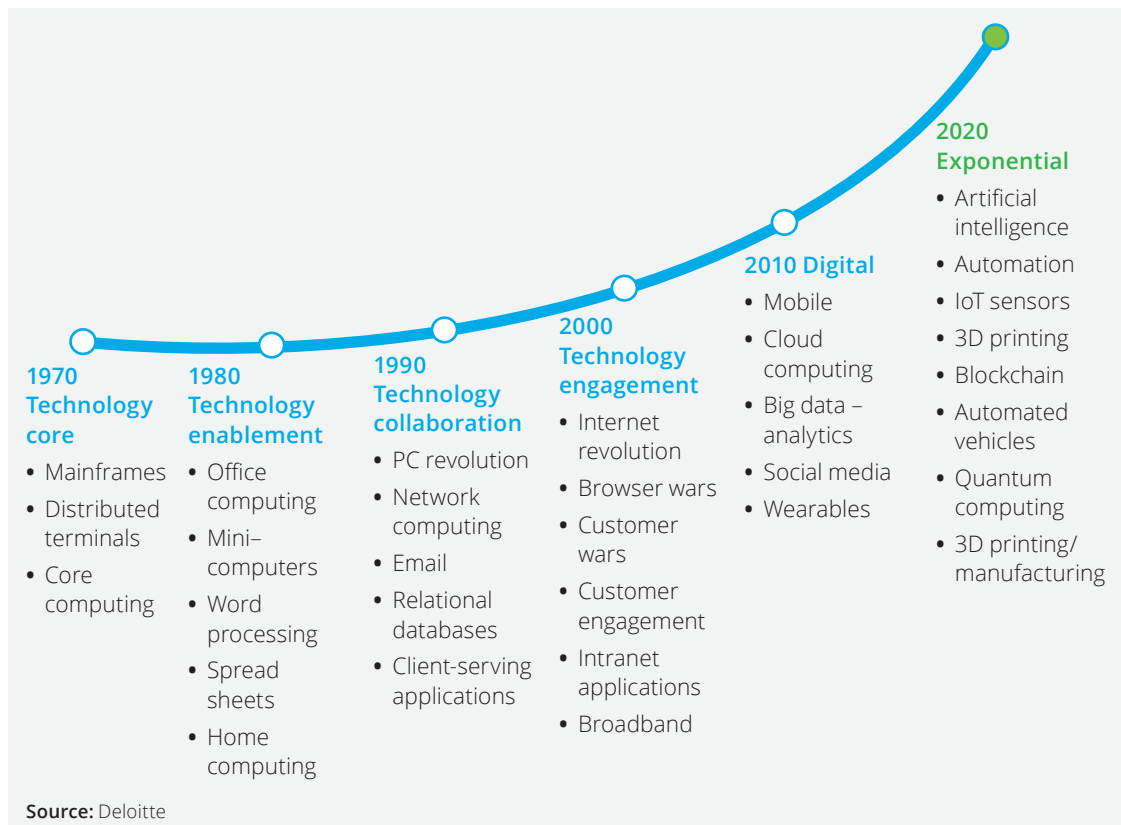
4. Disruptive technologies

Digital innovation is proving to be a profound force in our economy and society, disrupting many facets of life for all Victorians.

Introduction: An era of exponential change

Over the past 50 years, technological advances have brought about exponential change on society and the economy. Global computing power is doubling every two and a half years. Technology is rapidly changing the way we work, interact and move. The figure below summarises the disruptors that have characterised the last 50 years of technological change.

Figure 4.1 – Exponential technological growth



New, emerging and maturing technologies may not just influence – they could continue to revolutionise – the future of Victoria’s economy, the nature of work that people do, as well as the way we interact, travel and do business. The exponential trajectory of technological advancement suggests that the revolution in digital technologies has much further to run. Technologies such as mobile internet, big data and data analytics, the IoT, and cloud technology are already seeing increased penetration with the potential for much more to come. There are also many “exponential” technologies on the medium to longer term horizon that have the potential to have far reaching, transformative impacts.

Some current and emerging technological trends will continue to grow, while others may not live up to the hype.

The most notable technological trends in 2018 include:

- **The rise of big data** – across all facets of industry, government and community, the digitisation of business and services has yielded larger and more complex data sets than ever before – offering new and valuable insights.
- **The internet of things (IoT)** – IoT is a suite of technologies and applications that equip devices and locations to generate all kinds of information—and to connect those devices and locations for instant data analysis and, ideally, “smart” action.
- **Automation and artificial intelligence** – Robotic process and intelligent automation tools can now help businesses improve the effectiveness of services faster and at a lower cost.
- **3D printing** – also known as additive manufacturing – offers individuals and organisations the ability to break performance trade-offs, reducing the capital required to achieve scope and/or economies of scale.
- **Blockchain** – is a distributed ledger technology in which transactions (often made with “tokens” or a cryptocurrency) are recorded chronologically and publicly. Blockchain has gained prominence in recent years when Bitcoin (its original application) reached mainstream consciousness and is now changing the rules of transactions and is disrupting the role of traditional institutions.
- **How humans interact with technology** – human interaction with the internet has shifted from the most traditional medium – the computer, to the phone, to devices that allow us to ‘talk to the internet’.

How is this megatrend shaping Victoria?

Shaping our economy and the future of work

New technologies will leave very few industries or occupations undisrupted.

However, technology will disrupt certain industries more than others, meaning that the timing, nature and extent of change will vary for industries, occupations and regions of Victoria.

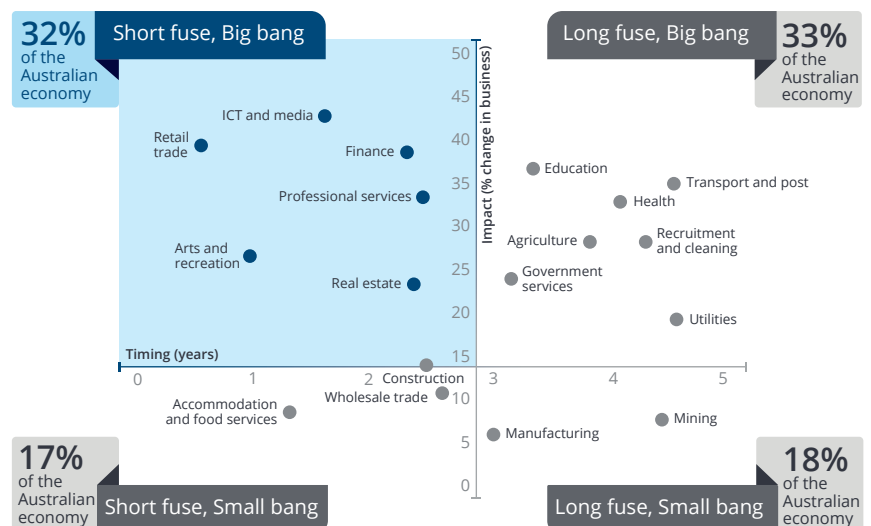
For example:⁷⁴

- Improved communication and computing technologies and increased use of robotics will improve the delivery and affordability of health care and medical procedures.
- Autonomous vehicles and robots will increase the productivity of the transport and logistics industry.
- Pre-fabrication and 3D printing will disrupt the construction industry.

- Improvements in data analytics, artificial intelligence and robotics will streamline and automate some of the tasks in finance and insurance, professional services, and administration and support services.

In the report *Digital Disruption – short fuse, big bang* – Deloitte assessed the extent (the size of the ‘bang’) and the imminence (the length of the ‘fuse’) of change in a digital disruption map (below). The industries that Deloitte expected to face both significant and imminent disruption include finance, retail trade, arts and recreation, professional services, and information, media and telecommunications – sectors that collectively comprise about one third of the Australian economy. Other sectors, such as education, health, agriculture and transport, were also expected to also face significant disruption into the near future.

Figure 4.2 – Exponential technological growth



Improving resource management and informing decisions

Disruptive technologies have demonstrated the potential to improve the way in which scarce resources are managed. While the benefits of digital agriculture are already well-understood, increased uptake and further innovation will enhance the efficiency through which scarce natural resources and other inputs are converted into food and fibre products. For example, moisture sensors in crops can provide an early warning of moisture stress, send alerts to mobile devices, and help calibrate satellite-based irrigation scheduling – matching water to crop need.

A recent study (“Precision to Decision”) found that full implementation of digital agriculture would increase the gross value of Australian agricultural production (including forestry and fishery outputs) by 25 percent (or \$20.3 billion) on 2014–15 levels.⁷⁵ The Victorian Government is seeking to enhance the use of smart digital technologies on farms through a series of IoT trials across Victoria.⁷⁶

Blockchain technology could improve environmental practices and transparency

New technologies are increasing transparency and accountability in supply chains. In particular, blockchain has demonstrated significant potential to increase transparency, efficiency and accountability of organisations, which could have significant implications for the environment:

- **Supply chains** – blockchain could enable transparent tracking of products from origin to retailer.
- **Energy** – peer-to-peer blockchain based energy system would allow individual customers to trade energy amongst themselves, thereby bypassing their retailer and reducing the need to transmit electricity over long distance. This could also help reduce the need for energy storage.⁷⁷

- **Tracking environmental treaties or pledges** – blockchain technology could enable transparent reporting (cutting down on fraud and manipulation) of important environmental data.
- **Tracking the carbon footprint of products** – blockchain technology could enable digital ledgers to track carbon emissions and credits transparently and reliably.⁷⁸

Blockchain technologies – specifically cryptocurrencies – could also be used to support environmental and ecological projects. For example, NaturesCoin is an Australian digital currency (still under development in 2018) that is designed to turn corporate social responsibility activities into assets, which is locked into a blockchain.⁷⁹

The role of technology in improving environmental monitoring

In future, businesses and government agencies will use IoT-enabled sensors to monitor the environment. Sensors will monitor environmental factors – such as noise, air, temperature, water quality and CO₂. Current technology allows sensors to collect data on these variables and provide businesses with automated alerts and data visualisations.

Spatial technology already plays a role in environmental monitoring – for example, through the tracking of wildlife using GPS systems. Satellite technology will continue to improve environmental monitoring in other ways. For example, CSIRO scientists have developed a satellite-based blue-green algae alert system, while satellite technology is already in use to monitor the health of the Great Barrier Reef.⁸⁰ Long-term and large-scale satellite monitoring can enable rapid detection in changes to the environment, such as land clearing, and can be used to efficiently identify suitable areas for biodiversity offsets.⁸¹

Low-cost, user-friendly and very compact air pollution monitoring platforms enable observations at high spatial resolution, in near-real-time. These platforms provide new opportunities to simultaneously enhance existing monitoring systems – and enable citizen science. While there are concerns over the quality of data that these platforms can generate, as with all technology, improvements are likely to occur over time.⁸²

Technology has increased e-waste

While technological advancement has the potential to positively address a number of environmental issues, it has also sped-up the generation of electronic waste (or e-waste). Unwanted electrical products (such as computers, phones and televisions) containing hazardous materials often end up in landfill, yet these products can be up to 90 percent recoverable.⁸³

E-waste is growing three times faster than general municipal waste in Australia, as the lifespan of products becomes shorter. The Victorian Government is banning e-waste in landfills from July 2019, and has announced a package to enable greater recovery of recovered e-waste materials.⁸⁴

The sharing economy – enabled by technology

Developments in information and communications technology have significantly lowered transactions costs, enabling the emergence of the sharing economy. The defining feature of the sharing economy is the existence of a platform connecting buyers and sellers in a market and reducing transactions costs, where the buyers and sellers are individuals or small businesses.

The sharing economy could become an important factor in reducing the Victorian, and global environmental footprint. It represents a low-ownership, reduced production/consumption method of organising assets in an economy.

This model lowers the barriers for access to goods or services at out-of-reach price points – a category that includes a lot of new, sustainable technology (such as solar panels).

Autonomous vehicles

Autonomous vehicles (AVs) are, in 2018, on the verge of becoming a reality for Victorians in the coming decades. There will be clear societal, economic and environmental benefits for all Victorians – impacting on the transport network, human health, ICT systems, land use, economy and natural environment.⁸⁵

AVs have significant potential to influence Victoria's environment. Studies have shown that AVs consume less fuel than human-driven vehicles, as well as reducing unnecessary braking which emits air pollution.

However, the overall impact that AVs have on the environment depends on a number of unanswered questions. As noted by Infrastructure Victoria, while there is a lot of information about automated vehicles, much of it is highly uncertain.⁸⁶ For instance:

- Will AVs encourage car owners to take more trips, thereby increasing the

environmental footprint?

- Will AV owners park their cars, or leave them to drive around on the street to avoid parking fees?
- Will private AV ownership and usage be commonplace? Or will users share the majority of AVs through sharing platforms (such as Uber).

How will this megatrend impact the Victorian environment?

The impact of this megatrend on Victoria's environment in future would be mostly positive:

- Big data and remote sensing technologies will continue to increase resource efficiency. Environmental data collection will be further enabled by citizen science. Improved use of GPS technology and IoT technologies could enable faster detection and improved responses to environmental issues and adverse events.
- Improved environmental management through increased detection and response capability, through sensors and citizen science. This extends to water and air quality, fire risk management, and land health, to name a few.
- AVs could require substantially less road space, decreasing the need to encroach

on wildlife and enabling existing road spaces to be repurposed or rehabilitated. They may also decrease energy and fuel consumption, as well as reduce non-fuel based air and noise pollution from vehicles through more efficient braking and acceleration. However, as outlined above, road vehicle use could increase, rather than decrease, with the adoption of automated vehicles.

- E-waste is likely to continue to be an issue. While the Victorian Government has a policy in place to ban E-waste ending up in landfills, new challenges will continue to emerge as new technologies evolve. For example, the recovery of electric vehicle car batteries may become an emerging trend over the next 20–30 years, as early-generation electric vehicles reach the end of their useful life.



5. Natural resource constraints

The rising global population is escalating the pressure placed on finite natural resources used to satisfy basic human needs. As we grow, our fixed quota of natural resources including water, non-renewable energy, minerals, land, fish and timber will come under more strain illustrating how growing demand for finite natural resources creates the potential for conflict between competing interests.

Growing demands for natural resources

Demand for food, water, waste management and land for household, agricultural and industrial use will continue to grow as population expands – resulting in a likely reduction in fresh water supplies for households, industry and the environment, and impairments to biodiversity. Sustaining the projected population of 8.3 billion people in 2030 will see a 35 percent increase in food demand and a 40 percent rise in water demand globally from 2012 levels.⁸⁷

Food and shelter are essential elements to supporting human life, of which both these needs require

the use of land which can be used for numerous purposes. Globally, 80 percent of deforestation has occurred to support greater food production as forested areas are replaced by productive agricultural land.⁸⁸ Although harvesting of native Victorian forests have slowed significantly over the last 20 years, these areas remain at risk of removal to support the rising food and housing requirements of a growing population.

As Victoria's population grows, so too does the waste. Victoria produced 2.23 million tonnes of waste in 2016–17, a 4 percent increase from 2015–16, of which 64 percent was sent to landfill.⁸⁹

Other megatrends could compound natural resource constraints. While this megatrend focusses on growing human demands, other megatrends will either have compounding or offsetting impacts. For instance (as detailed in earlier chapters), climate change will likely compound natural resource constraints, while technology improvements could improve resource efficiency.

How will this megatrend impact Victoria?

Growing food demand will place constraints on primary industries

As outlined in the introduction to this report, Victoria's economy is underpinned by its large services sectors. Primary industries, however, sustain Victoria's large and growing population, and accounts for a significant share of Victoria's exports. Victoria's agriculture sector produced over \$13 billion in crops, meat and other livestock products in 2015–16.

Table 5.1 – Victoria’s agricultural industries, 2015–16.

Variable	Unit	Value
Gross value of agricultural production	\$million	\$13,080
Crops	\$million	\$4,836
Meat	\$million	\$4,642
Livestock products	\$million	\$3,601
Number of agricultural businesses	No. of businesses	20,776
Area of agricultural holdings	million hectares	10.7
Area of crop production	million hectares	4.1

Source: ABS Agricultural Commodities (7121.0), Value of Agricultural Production (7503.0)

Victoria’s commercial fishing and aquaculture industries generated 13,000 tonnes of seafood products, with a gross output of \$191 million. Victoria’s aquaculture output (in terms of volume) has overtaken its wild capture industries, reflecting a global shift towards farmed seafood products.⁹⁰

Table 5.2 – Victoria’s wild catch fishing and aquaculture industries, 2015–16.

Variable	Volume (tonnes)	Value (\$million)
Wild catch	5,889	\$13,080
Crustaceans	551	\$4,836
Molluscs	861	\$4,642
Fish	4,476	\$3,601
Aquaculture	7,146	20,776
Total	13,035	10.7

Source: ABARES Fisheries and aquaculture statistics 2017

Both of these industries will face greater natural resource constraints in future.

Australia’s household expenditure on food items will grow, with rising demand for food products stimulating domestic agricultural production to meet both our own domestic needs and the demands of a rising middle-class population in Asia. It is likely that Victoria’s ecological footprint will continue to grow as a result, since food is currently the largest contributor to this metric.

Using existing agricultural production methods, more water and land would be required. Potentially excessive water extractions could endanger on the lives of aquatic creatures and damage surrounding riparian corridors. In addition, as the need for food expands the risk of unsustainable fish extractions heightens as humans are expected to consume more of all foods. However, given that both resources will be constrained in future, new and innovative growing techniques will need to be adopted.

Water scarcity

A reliable and clean supply of fresh water is essential for the long term health and prosperity of any society. At the heart of many decisions regarding water management is a trade-off between the needs of households, businesses and the environment.

The expansion of Australia's population, and of the Asian middle class over the next 20–30 years will also continue to drive significant demand for agricultural products. While Victorian exporters stand to gain from this, this growing demand will place additional pressure on our water supplies. Food production is a water intensive process – in Victoria, water accounts for around 63 percent of water consumption.

Effective water management will be a critical priority to ensuring long-term food security. Adding to the strain placed on Victoria's natural water resources, the effects of climate change (see climate change chapter) will alter seasonal conditions and enhance the risk of crop failure due to extreme weather events.

Conflict over water resources is likely to play out in Australia in future. Ongoing water shortages could create further uncertainty over the future of agreements, such as the Murray Darling Basin Plan (CSIRO, 2012). Growing demands for consumptive water use will clash with demands for water for environmental flows, demands from other states, and other objectives for dam and waterway management.

Growing competition over land use will place greater pressure on the natural environment

The supply of land in Victoria is subject to three broad competing uses: primary production (including forestry, mining and agriculture), conservation and urban development.

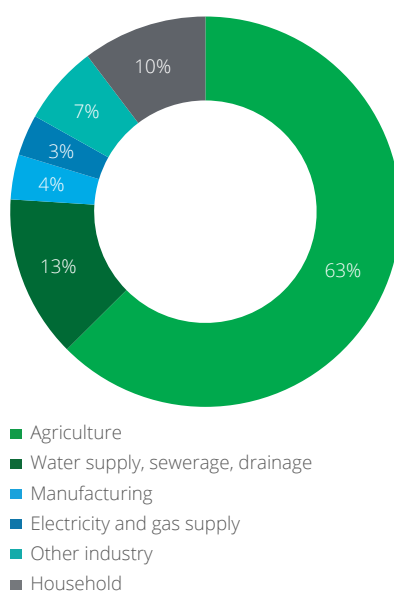
Conservation

Parks and forests are important for achieving numerous environmental objectives, such as preserving biodiversity, preventing land degradation, absorbing atmospheric carbon and improving water and air quality. Victoria's natural heritage and the positive impacts of natural ecosystem services, has seen a rise in the area of land occupied by reserves. While government policy has prevented the development of precious green spaces located in urban areas like Melbourne, the need to support future housing may see these policies shift over time.

Primary production

Historically, during the 19th and 20th century significant proportions of Victoria's land, predominantly forested areas were cleared to make way for greater agricultural production.⁹¹

Chart 5.1 – Victorian water consumption by sector, 2015-16



As a result of this, Victoria is the most cleared state, placing native biodiversity under significant threat. While the clearing of forested areas in Victoria has slowed significantly, areas covered by state forests in Victoria have continued to decline in recent years.⁹² While conservation strategies and government policies have reduced the rate at which deforestation occurs today, growing food demand could place native forests at risk of removal.

Since the introduction of forest management plans in the 1990s and early 2000s, native hardwood timber harvesting in Victoria has declined significantly. The table below shows that Victoria's forestry industry has, over the ten years to 2016–17, undergone a gradual shift away from native hardwood timber towards plantation hardwood varieties.

Table 5.3 – Victoria's log harvesting, 2016–17.

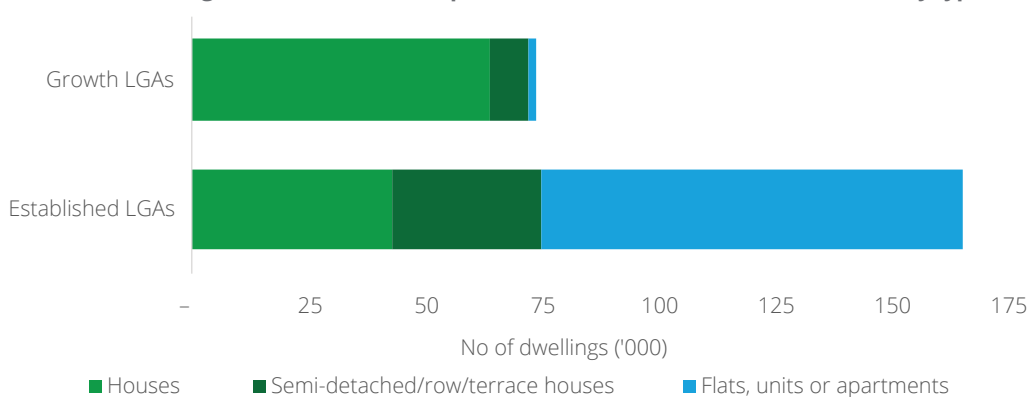
Variable	Volume (cubic meters)	10 year change (%)
Native hardwood	4,087	-52.2%
Plantation hardwood	11,365	180.5%
Total hardwood	15,452	22.6%
Softwood	17,691	21.3%
Total	33,143	12.9%

Source: ABARES Forest and Wood Products Statistics

Urban encroachment

Based on the current growth trajectory, Victoria's future population growth will also coincide with greater urban encroachment on both agricultural and natural reserves, particularly in the Greater Melbourne area. Urban sprawl has persisted since Melbourne was first established as a metropolitan area. Between 2011 and 2016, Melbourne's six 'growth area' local government areas (LGAs) accounted for around 45 percent of Melbourne's residential population growth. Unlike established areas, the majority of new dwellings constructed in these areas are detached houses (See chart below).⁹³ Over those years, greenfield development and associated infrastructure has increased the urban area of Melbourne by near-record levels: 7,300 hectares.⁹⁴

Chart 5.2 – Dwellings constructed in Metropolitan Melbourne between 2011 and 2016, by type



Data source: ABS Building Approvals (Cat 87310.0)

Urban encroachment has been somewhat constrained since 2002 by the introduction of an urban growth boundary. However, with actual population growth continually exceeding expectations, the boundary was reviewed and expanded in 2010 and again in 2012, growing the area within the boundary by 43,000 hectares and 6,000 hectares respectively. The boundary has remained fixed since then – and can now only change by a majority vote in both houses of Parliament.⁹⁵

Becoming a more circular economy

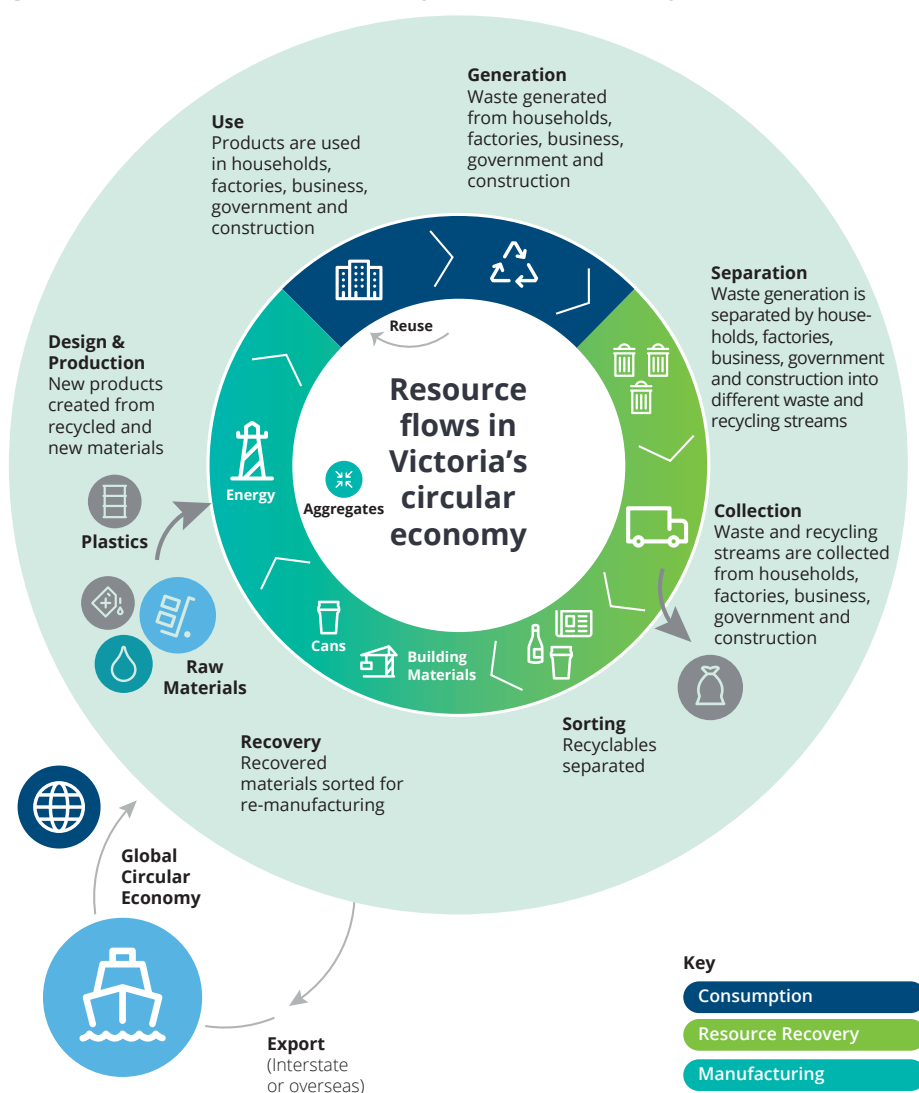
Making efficient use of finite resources throughout the economy will become increasingly important in Victoria's resource-constrained future. The term "*circular economy*" is used to describe a supply chain approach in which products, and the materials they contain, are used multiple times.

A linear '*take-make-dispose*' supply chain, can be made circular through resource recovery – where materials are brought back into the cycle for remanufacturing.

In some instances, Victoria is taking a leading role in promoting the circular economy. For example, in September 2018 Sustainability Victoria announced funding for a new research project to support end of life photovoltaic (PV) solar panels and other PV system accessories.⁹⁶

Recognising the importance of this issue, the Victorian Government has committed to developing a whole-of-government *Circular Economy Policy and Action Plan* by 2020, which will outline its broad waste management goals and direction for the future, following the principals outlined in the diagram below.⁹⁷

Figure 5.1 Waste and resource recovery in a circular economy



Source: Victorian Government (2018), *Recycling Industry Strategic Plan*

How will this megatrend impact the Victorian environment?

- Growing demand for food could place additional pressure on Victoria's water supplies. Much food production is a water-intensive process. The impacts of climate change may compound this further, as a fall in rainfall reliability will increase demand for water from catchments.
- Conflicts over land uses are at the heart of many environmental issues facing the state, and this trend is likely to continue over time. Population growth will result in further urban encroachment; while food and fibre demand will continue to grow resulting in stronger demand for land in agricultural and forestry industries. Land clearing for these purposes can have numerous impacts:
 - Localised issues affecting the quality of land across Victoria (including eutrophication, acidification, erosion, topsoil loss and the spread of noxious weeds) that are typically linked to native vegetation clearing would become more prevalent.
 - Land clearing also causes fragmentation of habitat, which can threaten the survival of species.
- An emerging environmental issue is the sustainability of aquaculture practices. Aquaculture businesses can impact surrounding marine environments. For example, build ups of organic materials beneath fish farms can impact on the flora and fauna of an area, which can impact sediment chemistry and water quality.⁹⁸
- Failure to make efficient use of finite resources throughout the economy will contribute to a more resource-constrained future for Victoria.

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