



A new choice
Australia's climate
for growth

November 2020

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Above - Double Bay, New South Wales.

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Foreword

While economic growth is sometimes treated as preordained, in reality it is not. Our understanding of economics has changed over time, as we have understood better the role of markets, of regulations, of finance, of consumer preferences and, increasingly, the environment.

Economic models, at their core, have assumed a system of production where unconstrained greenhouse gas emissions sit alongside unconstrained economic growth. A virtuous and unconstrained model of growth has underpinned the vast bulk of economic thought and economic modelling.

This linear and unsophisticated view of the world has come up against science, which tells us that the current system of economic production as we know it is generating physical changes in the climate. In turn, these changes are negatively affecting the environment, putting at risk economic growth and our quality of life.

With this knowledge, the assumption of unconstrained emissions and unconstrained growth is disrupted.

Yet, with climate change, the debate immediately, and almost exclusively, turns to a question of the costs of doing something about it.

What this report reveals is a fundamental flaw in how we are viewing the debate on climate change; we are all missing the point. We view the costs of action against an economic future where the basic assumption is that the economy will keep growing with unconstrained emissions. It is no wonder, then, that any debate

about climate change turns up a large cost of action with scant benefits from change.

The economic baseline that we are conducting this debate against is fundamentally flawed. In its place, this report develops a baseline where unconstrained emissions are not consistent with unconstrained growth.

Deloitte Access Economics has constructed a view of the Australian economy where the physical damages to the environment cause damage to the Australian economy if there is inaction, or mis-action, in preventing climate change. This is Australia's economic trend without global or domestic change.

This report provides a basis for a more hopeful and useful debate about climate change – because Australia's current debate no longer appropriately serves Australians, our economy or our decision makers. The policy choices over the next 2-3 years are the choices that will shape the next 10-20 – this is the narrow and unforgiving window of time we all have to choose the change that will prevent a warming world, and the devastating economic consequences that come with it.

Our Chief Economist, Chris Richardson, has a saying that *"...everyone has a second job in life – the job of leaving the world a better place..."* Never has that been more true or apt than in the analysis and insights of this report in creating Australia's climate for growth.



Pradeep Philip

Partner, Head of Deloitte Access Economics



Surfers Paradise, Queensland.

A new choice

If climate change impacts were distinct from the health and economic crises caused by the global covid-19 pandemic, that would be easier for Australia. But both crises and their solutions are linked – and this means Australia has a new choice to make.

Our world demands more from us all every day. Our economy is geared to produce more so we can consume. We need to learn new things to get, or keep, a job. And we now balance the needs of our public health in the face of covid-19 with those of the economy in a global recession. All the while technology changes daily, and the world stage continues to offer a series of economic and geopolitical plot twists.

The pace and scale of change confronting us all in 2020 – while not equal or just – has been universal. And the global covid pandemic has demonstrated the consequences and costs of overlooking catastrophic risks.

The next big risk

The risks of a warming world and a changing climate due to our economic activity, while more gradual, would be as great as those modelled by covid, if not worse. Not only is it increasingly clear that the costs of climate change are rising each year, the costs associated with reducing the risks from it are also rising with each year of delayed or insufficient policy action.

As public and economic policy rapidly progress to create recovery from covid, the (in)consistency of our understanding of the economic impacts and consequences of climate change, and climate change mitigation policy, stand out.

This last year has shown the consequences and costs of overlooking catastrophic risks. Thus, as we focus on recovery, we also need to do more to understand the economic impacts and consequences of that other big risk – climate change.

Climate change is the next big risk we all face – so how do we account for it in recovery?

Deloitte Access Economics believes that a 'business as usual' economic growth trajectory is innately miscalculated if it does not account for the damages and impacts of climate change.

There is no 'standard' economic recovery from covid that Deloitte Access Economics can estimate that does not include the effects of a changing climate on Australia's economy in the long-term.

Economic risk today looks a lot like the risks of tomorrow

The economic paradox that has gripped Australia for the past decade endures: *the economic fundamentals that make Australia strong today, are equally what expose the economy to disruption and change in the future.*

Looking ahead, this paradox only becomes more wicked. Some of the most significant risks to Australia's economic growth trajectory are the physical risks associated with a changing climate and the unplanned economic transition risk from the world's response to this changing climate.

The analysis in this report shows that the Australian industries hardest hit by the pandemic, are also the most vulnerable to the effects of a warming world and climate change. Australia's agriculture, construction, manufacturing, tourism related industries and mining sectors all feature consistently in the top industries exposed to the risks of covid, climate change and unplanned economic transition as the world responds.

Deloitte Access Economics estimates that the top six industries:

- Hit by covid – in looking at weekly ABS payroll data – represent 32% of all employed people in Australia.
- Most exposed to the physical damages from climate change today, represent 46% of all employed workers.
- Most emissions intensive in their output represent 23% of all employed Australians. Australia's emissions intensive industries are vulnerable to disruption as the rest of the world changes – *the world may not want what Australia has to offer.*

Taken today, on average, Deloitte Access Economics estimates that **over 30% of employed Australians are exposed to economic disruption and risk from covid, climate change and unplanned economic transition as the world responds.**

While this is a significant number of jobs and growth at risk – enough to drive recessions – it is not all doom and gloom. The good news is that the remaining 70% of the workforce and Australia's GDP is able to help create the change and a new economic trajectory for Australia in a post-covid world.

By 2070...

\$3.4 Trillion

and over

**880,000
jobs lost**

in Australia's economy
from unchecked
climate change

By 2070...

\$680 Billion

and over

250,000

jobs added

to Australia's economy
from choosing a new
growth pathway

Over the next 50 years, unchecked climate change will reduce Australia's economic growth.

Doing nothing is a costly choice

In an economic future where Australia and the rest of the world does not mitigate the worst effects of climate change, the world has an emissions pathway that produces global average warming of above 3°C by 2070. While this is a global average, the reality is that in parts of Australia it will be much hotter. We will, truly, be the sunburnt country.

Over the next 50 years, unchecked climate change will, in average annual terms, reduce Australia's economic growth by 3% per year and cost around 310,000 jobs per year.

Deloitte Access Economics estimates by 2070, the economic cost of this will have doubled on average, **shrinking Australia's GDP by 6% – a \$3.4 trillion loss in GDP** in present value terms.¹ Such economic losses are nearly equal to the impacts of covid on the Australian economy today, occurring by 2055.

Let's repeat that: by 2055 Australia will experience economic losses on par with covid, getting worse every single year due to unchecked climate change.

Economic damage on this scale costs the economy 880,000 jobs by 2070.

For people in their 20s, 30s and 40s today, those losses are experienced in their lifetime. For a generation of Australians, their economic futures, and that of their families and friends will be profoundly disrupted by the consequences of unchecked climate change. But the effects of this will not be uniform across Australia.

This warming world is no joke. It will affect our ability work outside – building houses and infrastructure that we critically need. It affects our choices on where to live and holiday – as sea level rises and riverine flooding increase in intensity and impact. It affects our ability to play – hotter days means less outdoor playtime. We could even see the death of the Boxing Day Test and weekend club sport if things go on unchecked. That is a loss of the Australian way of life.

There is no free ride for Australia – while doing nothing is a choice, it is not costless.

¹ Using a discount rate of 2% to estimate the net present value today. All present value figures use the same discount rate. For discussion on this, refer to the Technical Appendix.

There is great opportunity for Australia to act on climate change today.

But the unprecedented global health crisis brings unprecedented opportunity

There are many choices that need to be made today to shape Australia's economy for the future – and clearly doing nothing is not an option. Rightly, economies globally are all facing the same challenge: *how to shift off an economic baseline that was already changing, and recover to a 'new' resilient economic path post-covid?*

Both government and private sector investment is needed to fill the chasm covid has left in the economy. This investment should be used to accelerate Australia's inevitable shift to a low emission economic structure – one that avoids Australia running off another economic cliff in a few years' time.

Investing in the inevitable shift to a low emission economy for Australia is about providing jobs in high-growth industries, investment in the upgrade and replacement of Australia's infrastructure, technological progress and emissions efficiency in traditional economic sectors.

This is a new growth path. And this path can and should drive productivity in all the right places and facilitate deliberative disruption – out with the old drivers of growth and in with the new.

But a new growth future is not dreamland. Any structural adjustment to an economy has challenges as change occurs. But the technologies, policy options and ideas to create a new climate of growth in Australia that is resilient to future risks are available today – **Australia needs to choose to change and get on with it.**

Choosing net zero is an economic necessity

Australia pays a high price of a global failure to deliver new growth in recovery. Compared to this dismal future, Deloitte Access Economics estimates **a new growth recovery could grow Australia's economy by \$680 billion** (present value terms) and increase GDP by 2.6% in 2070 – **adding over 250,000 jobs** to the Australian economy by 2070.

If we could spend today to prevent the next great recession from climate change, why wouldn't we?

These are the gains, the opportunity, for Australia to claim by being a country that reaches net zero emissions, sooner rather than later, to limit global average warming to 1.5°C along with the rest of the world.

This would not just be an achievement of a target or goal for Australia. Limiting warming to 1.5°C above pre-industrial levels, or no greater than 2°C, by 2050 is an economic must. A new growth recovery sees Australia's economy growing and the creation of employment – where it otherwise is experiencing losses.

Australia being part of – if not leading the way – in the global shift to net zero in a new growth recovery is in the national interest.

Pay today to stop the next great recession

A net zero future, even limiting global average warming to 1.5°C by 2050, does not mean the world is climate change or damage free.

The road to a better future is bumpy. To some extent, because meaningful action has not been taken to date, there is an extent of **'locked in' global warming** which makes the costs of action higher than necessary. And every year

of delay or mis-action, makes this task that much harder and that much more expensive. In a new growth recovery, Australia is still feeling the effects of 1.5°C of global average warming and Australia's economic structure is adjusting to reduce emissions intensity with the rest of the world. This creates a twofold economic effect: damages occur with any degree of warming to 2050, and the adjustment costs in the economy of mitigating this damage is worn as the transition to net zero occurs.

The economic costs of the 'locked in' global average warming that occurs and moving to net zero by 2050 is a 0.1% loss in GDP growth, on average, over the 30 years to 2050. This 0.1% loss in Australia's GDP by 2050 is estimated to be \$90 billion, in present value terms. Of this \$90 billion cost of moving to net zero, \$23 billion, or 26% is due to the locked in impacts of climate change. The remaining \$67 billion, by 2050, represents the cost to the economy of reducing emissions to reach net zero in a new growth recovery.

A \$67 billion cost to transform the economy by 2050 is a small price to pay, relative to the size of our economy. In dollar terms, **for comparison, the current JobKeeper**

program is costing the federal budget just over \$65 billion this year alone – and this is the necessary price Australia is paying to minimise the worst economic consequences of covid.

If we could spend today to prevent the next great recession from climate change, why wouldn't we?

In this together

An economic feature of climate change is the shared nature of the problem – the climate does not care about geographical borders, geopolitical postures, or for ideological reasoning.

The shared nature of the climate means that while steps can be taken to prepare for the risks of climate change – and to seize the opportunities of new markets that tackling climate change offer – the ultimate solution can only be co-ordinated global action.

The reality for Australia is that we stand to lose the most from unanswered climate change, but also stand to gain significantly from action. The ultimate global objective is to limit warming – this requires transformation at a global level and in Australia, so we keep up competitively and do our fair share.

But when policy action and investments are delayed while we wait for the world to change around us – and the global temperature goal remains – the world will change, and Australia's inevitable transformation to keep up will cost more as we will need to do more with less time.

For a middling diplomatic and economic power, Australia has every incentive to drive the global agenda for the national interest.

The analysis in this report is foundational to serving that purpose. The delayed COP26 forum in 2021 is critical for driving global action and steering economic recovery towards a resilient global economy.

Where Australia's States and Territories, along with the Australian Government, can be armed with the analysis of the impact of climate change on their geographies and sectors – and the alternative pathways each want to pursue – **Australia can quickly develop a strategy. This policy work is the bread and butter of governments at all levels – there are no excuses.**

In times of uncertainty, defining and realising the scenarios that mitigate risks to economic and social life is more critical than ever before.

Equally, this can be true for business. The analysis shines a light on the impacts of climate damages and the benefits of a new growth recovery.

This helps **define the economic endgame that industry sectors need to play at to get their decarbonisation plans underway** – because without an economy wide view, it is difficult to gauge the extent to which a sector or an organisation needs to play in reducing emissions.

In times of great uncertainty, defining and realising the scenarios that mitigate the greatest risks to economic and social life is more critical than ever before.

This report provides a basis for business, industry and government to further consider such scenarios – to develop sector and business targets, to drive a policy and regulatory approach for a balanced transition of the economy and building resilient growth and jobs for the future.

It is the nature of the problem that its solution is found together, or not at all. Australians have already had enough risk for this decade – *it is time to choose change and craft a better, more resilient and sustainable, future.*

It is time to get on with the task of preserving and enhancing Australia's way of life for this generation and those yet to come.

Choosing change checklist:



1. Most to lose, most to gain:

Australia needs to drive the global agenda for action to mitigate climate change in the national interest.



2. What gets measured, gets done:

Australian governments need to understand the impact of climate change on their geographies and sectors. Understanding impact is the foundation for decision making.



3. Get on with it:

Business, industry and government need sector, organisation and economy-wide strategies to reach net zero emissions by 2050.

Creating new growth in recovery

As Australia cushions the economy to the effects of the pandemic and recovers, there is a need to think of resilient investments for recovery: good investments. Ones that make the economy robust to future challenges.

In January 2020, the International Monetary Fund (IMF) cut its forecasts for global economic growth, predicting the global economy would expand by only 3.3% in 2020.²

By the April 2020 update, the global economy was projected to contract sharply by -3% in 2020, and by June 2020, global growth was projected at -4.9% in 2020.³ The 'Great Lockdown' due to the fallout of the global covid-19 pandemic had taken a full effect.

Like catching a falling knife

Forecasting economic outcomes and growth is difficult at the best of times, let alone in a global pandemic the likes of which modern economies have not experienced. Deloitte Access Economics' own Chris Richardson said that economic forecasting in the time of covid was like 'catching a falling knife'.

While economists, businesses and public health officials have all rightly been focused

on forecasting the impacts of the immediate pandemic – and determining the best course of action to protect public health, employment and livelihoods – the focus has begun to shift to forecasting economic recovery.

Will the recovery be 'V' shaped? 'U' shaped? Maybe even a 'W'? What will the path of economic recovery look like?

While the January 2020 IMF global growth outlook was way off, they had one thing right: a cautioning that the continuation of the trends of climate change could inflict even bigger economic losses across more countries overtime.

The prescription? That countries should position themselves to counter the next downturn by preparing in advance a contingent response that features a central role for investment in mitigating climate change, as well as investments that strengthen growth and ensure the gains are widely shared,

² World Economic Outlook, IMF January 2020

³ World Economic Outlook, IMF April 2020 and June 2020

As governments and business put their balance sheets to work in economic recovery, there is a need to create new growth that mitigates the worst costs of climate change.

including education, health, workforce skills, and infrastructure.⁴

The economic crystal ball couldn't predict back in January that the next downturn was merely weeks away, and countries would use all their fiscal and monetary fire power to minimise the losses from the sharpest economic contractions ever seen.

But as we look to estimate economic recovery trajectories and determine the brightest path for economic growth – we cannot lose sight of the ever-present risk of a changing climate from a warming world. A risk that pre-dates the worst impacts of covid-19, a risk that Australia was experiencing firsthand as we started the year with a 'black summer' that rattled the Australian psyche.

The economic impacts of covid, the impacts of catastrophic tail risk, cement that Australia cannot afford – and does not want – 'black summers' and the worst costs of climate change to become the trend.

The choices to be made in recovery in the next 1–3 years will affect the next 10–20.

In choosing economic recovery pathways there is a need for long-term, universal policy that recognises the complexity and interconnectivity of climate change, technological disruption, and industrial transition.

Moreover, this recognition extends to the understanding that the distribution of the costs and benefits will occur across generations and across all sectors of the economy. It requires a focus on competition and efficiency, developing pathways for new growth measures and prioritising the expansion of economic value creation – and the good jobs that come with it.

It requires everyone to choose change – and to plan for it, today.

Where it is accepted that human induced global warming causes climate change, it must also be accepted that a 'business as usual' growth trajectory is miscalculated if it does not account for climate change.

Economics of a warming world will hinder recovery

The current public health and economic crisis due to the impacts of covid-19 has revealed several lessons.

Firstly, whatever you think is historically true in public policy and economics does not necessarily hold in a crisis. With apologies to Lewis Carroll, with a blink, what is up is down and what is down is up.

This taught us a second key lesson – Australia's institutions work. Government, bureaucrats, the financial system, business and communities can step up and work together effectively in a crisis.

Which has taught us the third – **economic and policy problems of seemingly insurmountable odds can be solved**. When our minds are open to new frames of thinking and there is confidence in our institutions – and the experts that run them – we deliver the types of policy outcomes business and communities crave.

The final observation has been that not all investment will be created equal. This year, the pandemic will see global emissions fall

by more than in any other year on record. But a global pandemic and resulting economic crisis is not a sustainable approach for averting the worst impacts of climate change.

It has taken a global pandemic to demonstrate the consequences and costs of overlooking catastrophic tail risks. The risks as a result of a warming world and a changing climate, while more gradual, would be as great as those modelled by covid-19, if not worse.

And as it becomes abundantly clear that not only are the costs of climate change rising each year, it is also evident that the costs associated with mitigating the risks are rising with each year of delayed action.

As public and economic policy rapidly progress to recovery – and the private sector realigns its outlook – consistency in our understanding of the economic impacts and consequences of climate change become more important.

Deloitte Access Economics believes where it is accepted that human induced global warming causes climate change, it must also be accepted that a 'business as usual' growth trajectory is innately miscalculated if it does not account for the damages and impacts of climate change.

There is no 'standard' economic recovery that Deloitte Access Economics can forecast that does not include the effects of a changing climate.

Australia feels the heat

Australia's climate and geography, its decentralised collection of regional economies and proportion of national income generated by natural resources, are fundamental economic strengths. However, these strengths are also what expose Australia to the economic impacts of the physical risks of climate change.

Every region of the world is exposed to the physical risks of a changing climate, but just how exposed is Australia?

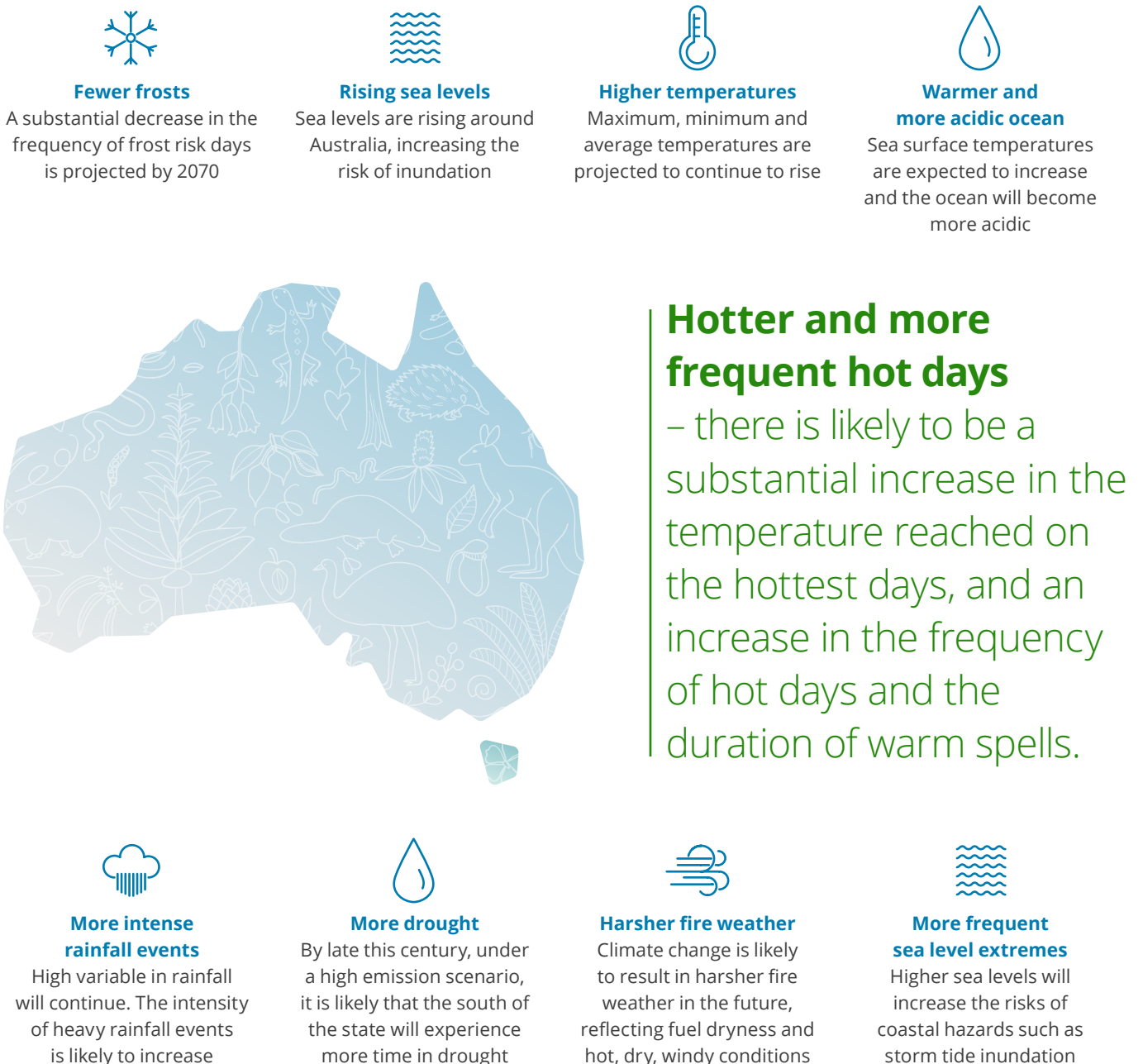
While it is impossible to fully predict the effects of a changing climate on Australia, scientists have clearly established that Australia is highly exposed to just about all of the climatic risks that arise from a warming world: *the research is conclusive in saying that warmer and more tropical climates are more likely to feel the effects of climate change.*⁵

The term 'climate change' represents the outcome of a complex interaction of physical, chemical, geological and biological processes as a result of higher concentrations of greenhouse gases in the atmosphere.

It is not currently known exactly how and when these interactions will play out (there isn't a model big enough), but there are some well-established climatic changes that will have implications for Australia.

⁵ Batten, S. (2018). Climate change and the macro-economy: a critical review. Bank of England. Staff Working Paper No. 706

Figure 1.1 How the climate will change Australia



Source: Deloitte Access Economics using CSIRO and Bureau of Meteorology (2019)

Climate change is changing economic structures. Some industries will be forced to undertake significant transformations in when, how and what they produce.

The heat falls on the economy

Climate damages will change economic structures – depending on their exposure to the changing climate and the impact this has on their productive capacity, each industry will be affected differently. Some industries will be forced to undertake significant transformations – changes in when, how and what they produce – while others will continue on a path that resembles today's activity.

Why is this? What is it about one industry that makes them more likely to be impacted than another?

The **Climate-Economy Disruption Map** (on the following page) brings together these questions into one 2x2 matrix. It simplifies what is an extraordinarily complex relationship between the climate and the economy (as well as the economy today and tomorrow). For each industry, **the extent of transformation required is a result of the physical risks of climate change and a sector's response to these changes**, both domestically and globally.

The greatest economic transformation will be required in industries that: have a reduction in, or change in the nature of, the inputs necessary for production (e.g. water, energy)

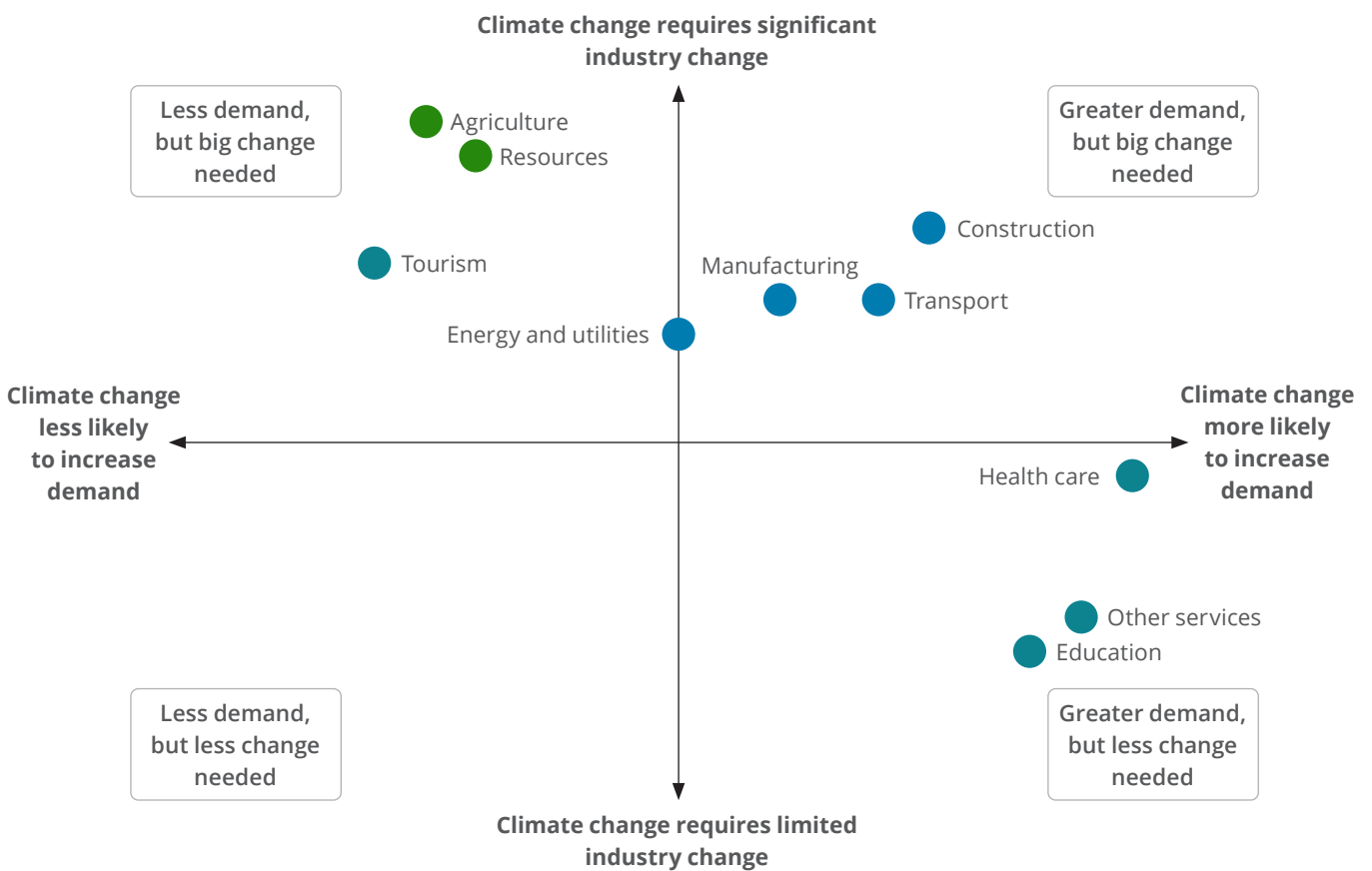
or a reduction in, or change in the nature of, the productivity of these inputs (e.g. worker productivity). These industries will need to develop new ways of delivering goods and services in the future if they are to remain globally competitive.

Industry change will also occur due to shifts in demand conditions. There are some industries which are not expected to see a substantial change in demand as the global economy transitions as a result of climate change.⁶ Some things are common to industries won't experience a significant shift: they are fundamental to a growing economy, not highly tradeable, and have a number of sources of strong demand. The implications of the physical risks of climate change will be different for industries with strong underlying demand versus those with more variable demand.

Sectors such as construction, transport, manufacturing and energy will be in demand, but must transform in response to climate change to remain economically relevant. While service sectors are in demand as population and economies grow, but are not directly affected by climate change in terms of how they operate and will transform relatively less in response to it.

⁶ This is not to say that there won't be cyclical changes in demand as the global economy reacts to climate change; rather, the trend impact on demand over the medium to long term is unlikely to substantially differ.

Figure 1.2 The Climate-Economy Disruption Map



- Primary sectors (i.e. production of raw materials)
- Secondary (i.e. transformation of raw materials)
- Tertiary sectors (i.e. services industries)

Source: Deloitte Access Economics

Australia is not immune from the economic risks associated with climate change or the way the rest of the world responds to it.

Where there is risk today, there is risk tomorrow

The risks presented by covid and climate change are not mutually exclusive. Industries and workers that are at risk as the world fights covid, are the same ones that are exposed to the risks from a warming world.

Economic risks and impacts from covid

We all feel the uncertainty that surrounds our current economic trajectory – many people have lost their jobs; businesses have been forced to close their doors and industries have been curtailed by the disruption of global supply chains due to covid. The disruptions and risks are very real.

Deloitte Access Economics' estimates that the top six industries hardest hit by covid – in looking at weekly payroll data⁷ – represent 32% of all employed people in Australia and 25% of GDP.

And what is vulnerable today, is even more vulnerable tomorrow. While the world is feeling the current crisis, the more gradual consequences of climate change are occurring at the same time.

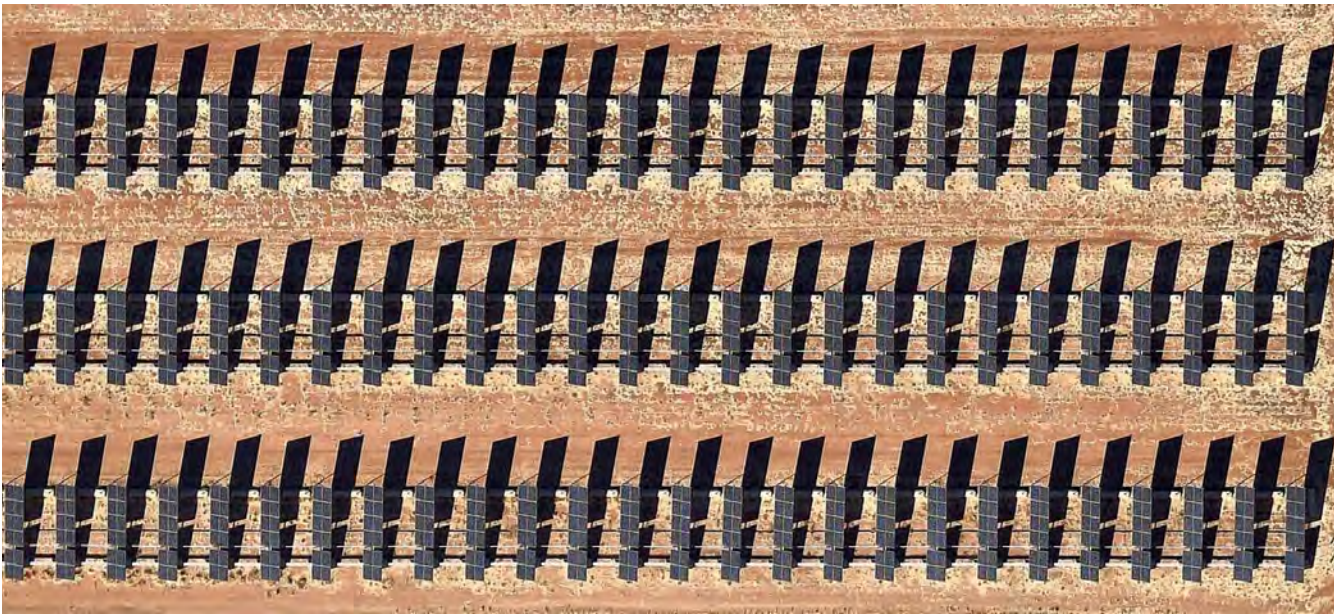
Physical risks from climate change damages

Going forward, some of the most significant risks to Australia's economic growth trajectory are the physical risks associated with a changing climate and unplanned economic transition risks from the response to this changing climate.

Australia's vast and variable landscape means that it is particularly exposed to the physical impacts of climate change. Deloitte Access Economics estimates that the top six industries which are the most exposed to the physical damages from climate change today, represent 43% of all employed workers and 38% of GDP.

Economic disruption risk as the world changes

At the same time, Australia as an emissions intensive, resource-based economy that is highly integrated into global markets is not immune from the economic risks associated with climate change – and the way the rest of the world decides to mitigate the worst consequences of it.



Solar farm, Alice Springs, Northern Territory.

Regardless of what transition path Australia chooses (including choosing not to transition), there will be economic shocks as the world transitions to a lower, and ultimately net-zero, emissions economy. These **global choices will be transmitted to Australia through trade, politics and changing consumer demand.**

Deloitte Access Economics estimates that the top six industries that are the most emissions intensive in their output represent 23% of all employed Australian's and 34% of GDP. These emissions intensive industries are vulnerable to disruption as the rest of the world shifts its preferences – changing what the world demands.

Looking at how industries are exposed to covid risk, physical climate damages risk and economic disruption risk shows the share of jobs and economic activity that are exposed in Australia.

Deloitte Access Economics analysis shows that those **industries hard hit by the pandemic, are also the most vulnerable to the effects of a warming world.** The economic fundamentals that make Australia strong today, are equally what can expose the economy to disruption and change.

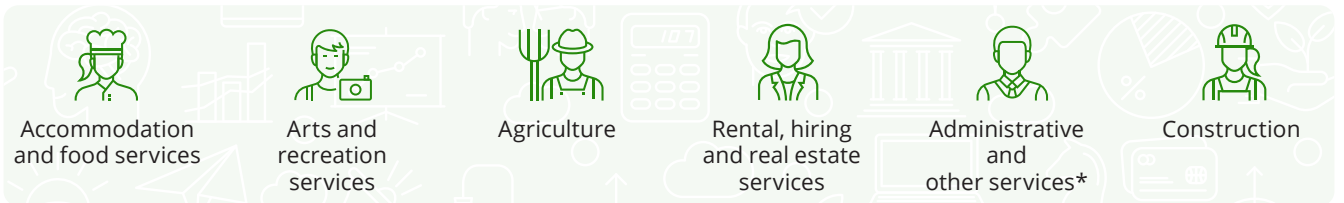
Agriculture, construction, manufacturing, tourism related industries and mining all feature consistently across the three risk categories: Covid economic risk, climate change risk and economic disruption risk.

30%

of employed Australian's are today,
on average, directly exposed to
economic disruption from covid
and climate change

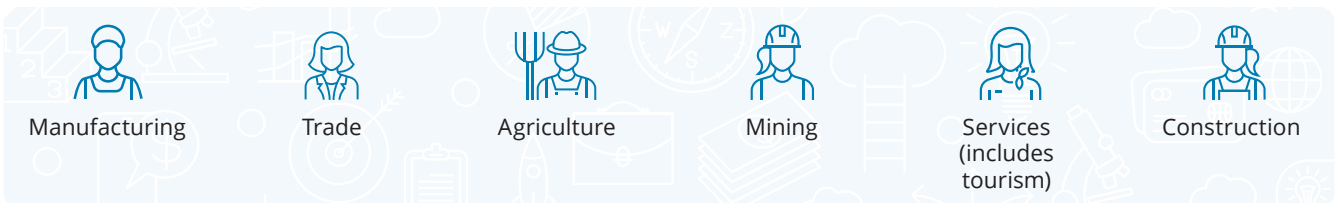
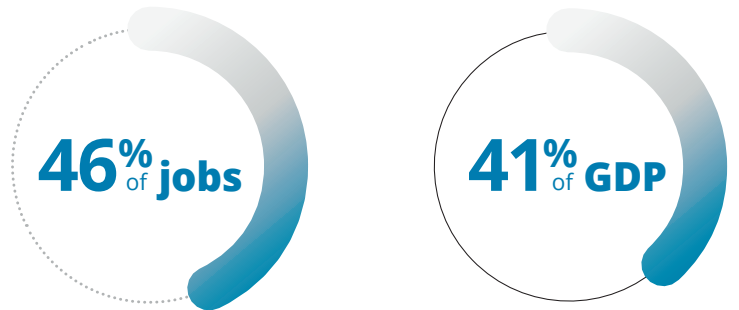
Covid-19 risk

Proportion of jobs and GDP in the top six industries that are most exposed during the global pandemic:



Physical damages risk

Proportion of jobs and GDP in the top six industries that are most at risk to the physical damages of climate change:



Economic disruption risk

Proportion of jobs and GDP in the top six industries that are most exposed if Australia does not plan for a global transition to a low emission economy:



*Administrative and other services includes administrative and support services, information media and telecommunications and other services.

Source: DAE-CLIMATE; Australia's National Greenhouse Accounts, National Inventory by Economic Sector, May 2020; ABS Weekly Payroll Jobs and Wages in Australia, July 2020; ABS Labour Force, Australia, Detailed, Quarterly, May 2020; ABS Australian System of National Accounts, 2018-19.

The risk is shared, but not uniform across Australia's regions

Where Australia has a relatively emissions intensive economic structure, and, emissions intensive employment, this exposes workers in these industries to the economic consequences of future transition decisions – particularly across Australia's regional economies.

Emissions intensive industries are vulnerable to disruption as the rest of the world changes and their economic structures to move to net-zero emissions – this change may see the world not want what Australia has to offer.

Combined, Deloitte Access Economics modelling and the National Emissions Inventory 2018 by economic sector⁸ determines the distribution of emission intensity by industry of employment. The distribution of emissions by industry informs the classification of the emission intensity ranges from Extremely Intensive as the highest, to Marginally Intensive as the lowest (see the figure over page and refer to the Technical Appendix for the full method).

23% of the Australian workforce is employed in emission intensive industries that are directly exposed to disruption if Australia does not plan for a global transition.

And this hits Australia's regions harder than most. For Australia, the short-term costs of disruption and unplanned economic change tend to be local – and a failure to address them in a timely way can put future benefits out of reach for regional economies. It is both a risk of consequences and timing.

This risk is would be further compounded where the rest of the world moves towards mitigation and low emission economies in recovery post-covid, and Australia maintains an emissions intensive status quo. For Australia, trade linkages and exports expose the economy to the impacts of inaction in response to the change, or mis-action.

This creates a need to mitigate:

- 1. Climate change and its consequences domestically, and**
- 2. the risk and policy consequences of the global move to net-zero already underway.**

⁸ ANZSIC 2-digit codes, noting some sub-industries are not available for reasons of confidentiality and do not sum accordingly.

No matter the recovery or transition pathway chosen, **an emissions intensive structure will not support a strong economic growth trajectory in Australia**; the risk of stranded assets, industries, communities and workers is intensified. And the lessons of covid have demonstrated that such risks are too great a cost to wear.

But the good news? This means 77% of Australia's workforce is not directly exposed to the disruption of an unplanned response to a global transition. But this 77% is not without risk. While they may not be directly exposed to industry downturns and shifts if Australia's economic response remains unplanned, they will indirectly feel the hit that the economy will inevitably take.

No industry or worker in Australia will be untouched by the disruption caused from a changing climate and the global economy's response. And where we can plan for it, that is the best weapon in Australia's economic arsenal.

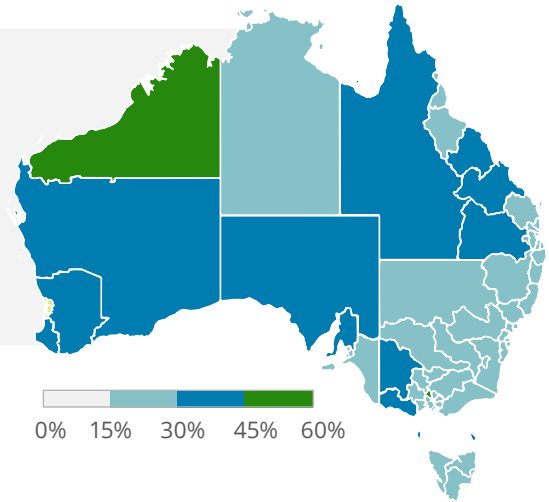
Where there is disruption, there is change. Change starts from the perspective of how people are affected, both positively and negatively, by the consequences of climate change. This starts with implications for jobs.

23% of the Australian workforce is exposed in emissions intensive sectors



Australian regions are more exposed to disruption and a failure to plan

Over half of Australian regions have 'emission intensive' employment that makes up 20–60% of total regional employment.*



Note: 23% of the Australian workforce work are in the top three ranges of emission intensive sectors as proportion of total employment.

* Regions as at the SA4 level

Marginally Intensive	<ul style="list-style-type: none"> Professional, Scientific and Technical Services Manufacturing (Textiles / Transport / Machinery / Equipment) Aquaculture, Fishing, Hunting and Trapping Agriculture, Forestry and Fishing Support Services Arts and Recreation Services Other Services 	44% of jobs
Moderately Intensive	<ul style="list-style-type: none"> Manufacturing (Food / Beverage) Wholesale and Retail Trade Rail Transport Accommodation, Food Services, Education and Health Services Gas Supply Water Supply, Sewerage and Drainage Services Finance, Insurance, Rental, Hiring and Real Estate Forestry and Logging, Wood, Pulp, Paper and Printing Building Construction Information Media and Telecommunications Heavy and Civil Engineering Construction 	34% of jobs
Intensive	<ul style="list-style-type: none"> Mining and Quarrying (Metal and Mineral) Manufacturing (Chemical and Minerals) Waste Collection, Treatment and Disposal Services Air and Space Transport Administration (public and services) Construction Services Other Transport, Services, Postal and Storage 	15% of jobs
Highly Intensive	<ul style="list-style-type: none"> Manufacturing (Metal) Road Transport 	4% of jobs
Extremely Intensive	<ul style="list-style-type: none"> Electricity Supply Agriculture Oil and Gas Extraction Coal Mining 	4% of jobs

Source: Deloitte Access Economics modelling using Australian Bureau of Statistics ANZSIC classification and the National Emissions Inventory 2018 Economic Sector classification. Note: Employment numbers may not add due to rounding. See Technical Appendix for detail.

A cost seen by some, is an investment to others. And it is not about 'green' investments or policy, it is about what is good.

There no such thing as green – just good

In economic recovery post-covid – there has been significant discussion on the need for 'green growth' and 'green recovery' policy.

Recent analysis from the International Energy Agency (IEA) and the IMF has outlined **a need for countries to address the core issues of the global recession and soaring unemployment – and doing so in a way that creates sustainable economic growth**, while being founded on cleaner and more secure energy systems.

While governments design economic recovery plans, the decisions made today will shape economic and energy infrastructure for decades to come and determine whether the world meets its long-term energy and climate goals.

A sustainable and 'green' recovery plan includes the acceleration of low-emission electricity sources, more efficient transport such as electric vehicles, the improvement in energy efficiency of buildings and appliances, the efficiency of production systems, and a boost to innovation.

And where a 'green' recovery is adopted between 2021 and 2023, the IEA and IMF estimates the benefits of a \$1 trillion p.a. investment (USD) – just 0.7% of global GDP – over the next 3 years, would see global GDP be 3.5% higher than it otherwise would be, with many ongoing structural benefits. Some 9 million jobs a year would be saved or created, and emissions would be 4.5 billion tonnes lower.⁹

The dividends of such investment will not be surprising to many. Because while **business has long been awake to the risks of climate change** – of policy and regulatory risk, international trade risks, consumer risks, and investor risks – **business has also been aware of the opportunity and the gains to be had from investing in the mitigation effort.**

⁹ IEA and IMF, 2020, Sustainable Recovery.

Australia's climate for growth requires good policy, good economics and good investments that mitigate risk and create returns to both business, society and the economy.

A cost seen by some, is an investment to others. And it is not about 'green' investments or policy, it is about what is good. Australia's climate for growth requires good policy, good economics and good investments that mitigate risk and creates return to both business, society and the economy.

And as Australia cushions the economy to the effects of the pandemic and recovers, there is a need to think of resilient investments for recovery: good investments. Good investments that make the economy robust to future challenges and avoids the economy running headlong into another economic wall in just a few years' time.

Recovery from the pandemic is crunch time to put emissions in structural decline and mitigate the worst effects and risks from a changing climate.

The Global Financial Crisis saw greenhouse gas emissions jump significantly as the world economy recovered, further stalling resilient economic progress. The Australian and global economy cannot afford this a second time round – cannot afford it economically, socially or environmentally.

All economies are recovering from covid off an economic baseline that was already disrupted and exposed to risk – because **climate change and economic transition is not a scenario, it is the baseline.**

The economic climate will change

As Australia recovers, without greater policy efforts, our future includes a changing climate and a warming world.



Climate change is not a scenario.
It is the baseline for decision making.

The growth in the global economic system is currently contingent on emissions intensive activity. Economic theories and models that provide the ability to understand emissions intensive activity and growth, are also maintaining society's 'business as usual' approach to preventing climate change.

That is, the **climate change economic paradox**: *the economic fundamentals that make economies strong on paper with emissions intensive production, are equally what expose economies to disruption from both the climate and economic transition.* And because the economic fundamentals are strong, it prevents the necessary policy and economic change from taking place.

Climate change is not an economic scenario, it is the baseline

And economic modelling is part of this wicked problem. Most **current economic models and their trajectories of trend growth assume unconstrained emissions.** This is economic baseline on which most decisions are made – government and business alike.

But **this baseline does not account for the economic consequences of unmitigated climate change or the world's response to it** – both due to damages, and/or inevitable policy responses to mitigate the impacts.

Climate change damages and mitigation policy are often modelled as a scenario due to the range of possibilities and future states. And this makes sense – to a point.

To leave the economic impacts of a changing climate out of economic baselines and decision making misses a trick. The Network of Central Banks and Supervisors for Greening the Financial System (NGFS), made up of 69 central banks including the Reserve Bank of Australia (RBA), this year released guidance the need to solve for this exact issue (and many others).¹⁰

Understanding and accounting for the longer-term effects of climate change on productivity, potential output and economic growth is critical to knowing the path of growth, and the distribution of the impacts of disruption.

¹⁰ NGFS, June 2020, The Macroeconomic and Financial Stability Impacts of climate Change: Research Priorities.

The economy impacts the climate,
and the climate impacts the economy
– and the interactions of these impacts
sets the economic baseline. This is true
for Australia and the rest of the world.

While current economic modelling miscalculates trend economic growth and broader economic impacts in the long-term (by not accounting for the economic impacts of climate change), Deloitte Access Economics has adopted a framework that integrates the economic impacts of physical climate change into a baseline economic trajectory for Australia (refer to Technical Appendix for details).

Put simply:

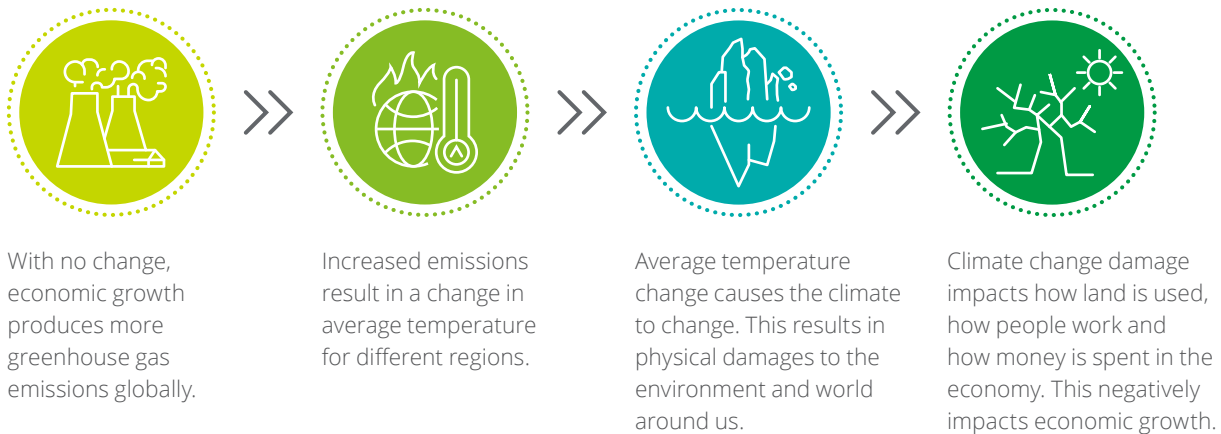
- 1. Model projected economic output (as measured by Gross Domestic Product) which causes emissions to reflect a Representative Concentrative Pathway (RCP) of emissions ranging between RCP6.0 and RCP8.5 to the year 2100.11 Producing a projection of emissions intensive economic growth.**
- 2. Increased concentration of emissions causes average global warming to rise above pre-industrial levels.**

- 3. Warming causes the climate to change and results in physical damages to the factors of production in an economy: the use of land, the way people work and capital flows.**
- 4. These damages to the factors of production are distributed across the economy, impacting GDP. Any change in emissions and/or temperature overtime results in a change to these impacts – the economy impacts the climate, and the climate impacts the economy.**

This understanding is incorporated in a modelling process, involving significant research on Australian specific climate impacts that act as inputs into Deloitte Access Economics' in-house Regional CGE Climate Integrated Assessment Model, the DAE-CLIMATE model (refer to Technical appendix for more detail).

11 International Panel on Climate Change (IPCC) adopted emission scenarios that reflect no significant additional effort globally to constrain emissions ('baseline scenarios'), leading to emission pathways ranging between RCP6.0 and RCP8.5. Deloitte Access Economics presents results out to 2070 in this report.

Figure 1.3 How the climate changes the economy



Source: Deloitte Access Economics

The economy impacts the climate, and the climate impacts the economy

Very few forces can impact the Australian economy like the damages associated with climate change; not when considering the scale, persistence and systemic nature of the impacts.¹²

Climate change, if left unmitigated, can erode the productive capacity of the economy.¹³ Changing how people work, what is produced and where it is produced, and shifting the preferences of what people buy.

Industries that rely on people power, such as construction, will experience ‘hotter’ working environments that not only disrupt comfort levels, but as temperatures continue to rise

the hotter conditions become a concern for workers health and safety and their ability to perform tasks.

As weather events become more severe and frequent, the costs to repair damaged infrastructure are funds that would be better spent on investments in new technologies, the deployment of existing technologies and research, and new infrastructure to support growing communities – all leading to long-term reductions in productivity growth.

The fundamental ‘driver’ of economic damages is rising temperature. As rising temperature induces climate change, economic output (as measured by GDP) is impacted through the physical damages that affect productivity and/or stock of factors of production (Figure 1.3).

¹² Climate Council (2019). *Compound Costs: How Climate Change is damaging Australia's economy*

¹³ Ibid.

How the economic climate changes



How workers work

Heat stress impacts on labour productivity

- As temperatures rise, heat stress on workers surpasses becomes a concern for the health and safety of workers and their ability to perform tasks.
- There is only so much heat stress the body can take.
- Before serious health consequences are reached (heat strain/stroke or death), at lower levels of heat exposure workers are subject to diminished mental task ability, diminished capacity to work at their former level and are at a higher risk of accident.

Deloitte Access Economics considers the 'slowing down' of workers and their ability to do their jobs results in **lower labour productivity**.

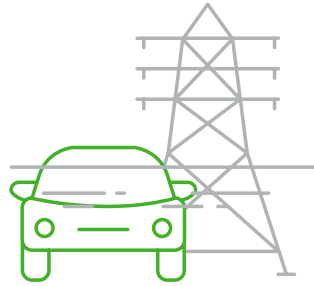


Where we live and work

Sea level rise erodes productive land

- Temperature rises are seeing land-based glaciers melt and water bodies experience warm. Put simply, the sea level is rising.
- Sea level rise affects land through the erosion, inundation or salt intrusion along the coastline, impacting agricultural output.
- In low lying and sea coast urban areas, residential and commercial properties will incur damage, require significant capital costs for repair or see people no longer live there. The property sector will see sharp property value adjustments.

Deloitte Access Economics accounts for **lost productive land** through sea level rise, and the level of productive activity on the land.



What is built and how it is damaged

Capital damages from investing in repairs, not new infrastructure

- As temperature rises, the increasing severity and frequency of extreme weather events damages infrastructure and capital, including dwellings, public infrastructure and machinery and equipment for business.
- Investments have to go into repairing what is damaged, and not the new investments that support growth.

Deloitte Access Economics accounts for capital damages as a percentage of annual **capital investment that is diverted to repair and replace damaged assets.**



How we live

Health damages on labour productivity

- Climate change can impact the range, abundance and spread of diseases.
- As extreme weather events become more severe and frequent, there is risk of death and injury to people.
- Climate change can affect air quality and diseases that result from air pollution – the recent summer of bush fires in Australia was a stark reminder of this.
- Climate change may also affect human health indirectly, through changes in food production, water resources, migration and economic development.

Deloitte Access Economics considers an **increased incidence of mortality** and morbidity on the working population, and the associated reduction in number of hours worked, resulting in lower levels of labour productivity.



How we holiday

Tourism damages on the flow of global currency

- The weather, and the climate, is a key consideration and driver of tourism around the world. But no more so than Australia.
- Where and how people can holiday using natural assets and attractions will change – making attracting domestic and international tourists harder.
- Tourism is a pillar of many economies and without it, many regional economies would struggle.

Deloitte Access Economics considers the **scale of loss of tourism money** circulating economies – and the impact on business, jobs and livelihood.



What and how we grow

Agricultural damages from variations in crop yields

- The agricultural sector is on the front line of climate change in Australia. Australia's vast and variable geography means that one part of the country can be suffering from the worst drought in living memory, while other parts are experiencing devastating floods.
- Climate change means rising temperatures, higher concentrations of carbon dioxide (CO₂) in the atmosphere and different regional patterns of precipitation.
- For agricultural production, this means fluctuations in growing conditions, water availability and the severity and frequency of extreme weather events; resulting in crop yield volatility and market uncertainty.

When faced with unmitigated climate change, even with adaption, there are limits to what farmers can do. Deloitte Access Economics considers **damages to agriculture as variations in crop yields** to be a significant impact.

\$3.4 Trillion

and

-880,000 jobs lost

The losses to the Australian economy by 2070 from unanswered climate change

The industries hardest hit:



-\$350 billion

lost in **Mining**



-\$330 billion

lost in **Manufacturing**



-\$1.6 trillion

lost across the **Services** sectors



-\$500 billion

lost in **Trade and Tourism**

For Australians in their 20s to their 50s today, the worst losses to the economy from climate change are experienced in their lifetime.

The economic cost of unanswered climate change risk

In an economic future where Australia and the rest of the world does not mitigate the worst effects of climate change, the world has an emissions pathway that reflects RCP8.5.¹⁴ This gives Australia an economic and emissions profile that produces global average warming of above 3°C by 2070.¹⁵

As the global temperature gradually increases to the end of the century, Australia feels the heat.

Today's generation of Australians will experience the worst impacts of a warming world

Deloitte Access Economics estimates by 2070, **the economic losses to Australia from unmitigated climate change are \$3.4 trillion in present value terms – or 6% of GDP.** Such a loss results in 880,000 jobs lost in 2070 alone.¹⁶ On average over the 50 years to 2070, that is a loss of 310,000 jobs per year and 3% of GDP.

For people in their 20s, 30s and 40s today, those losses are experienced in their lifetime. Their economic futures, and that of their families and friends will be profoundly disrupted by the consequences of unmitigated climate change.

Looking earlier in the century to 2050, the year in which current policy commitments aims to achieve net-zero emission economies and limit global average warming to 2°C – **the pathway of inaction or mis-action leads to economic losses of \$1.1 trillion in present value terms by 2050 – or 3.6% of GDP. This loss sees almost 330,000 jobs lost by 2050.**

On average over the 30 years to 2050, that is a loss of 135,000 jobs per year and 1.8% of GDP. Most Australians in their 20s to their 60s today will witness the effects this loss in their lifetimes.

¹⁴ This puts the world on a trajectory to reach a global average temperature of above 4°C by 2100, aligned with RCP8.5. Refer to Technical Appendix for discussion on the use of RCP8.5 for modelling in DAE-CLIMATE.

¹⁵ This analytical reference case assumes that countries do not meet their Nationally Determined Contributions (NDCs) and the global economy broadly follows the emissions pathway RCP 8.5 (based on the IPCC's fifth assessment report, 2014).

¹⁶ Employment figures reported are reflective of the total headcount of employee jobs lost – both part-time and full-time equivalents. The ratio for conversion of full-time equivalents (FTE) (modelled by DAE-CLIMATE) to total headcount has used an FTE ratio based on 2016 Census data.

Losses compound over time as temperature rises

Losses of this magnitude far surpass the devastating economic consequences we are all feeling today from the impacts of covid.

By 2055, Australia will experience economic losses on par with covid due to unchecked climate change.

A loss of this magnitude is difficult to comprehend. And while these economic losses are occurring in a larger economy in the future, with more people, new industries and new types of work – it is not a loss that is comprehensible or comparable in contemporary economic data.

All industries are hard hit, but some more so than others

The worst effects of a changing climate are felt across every Australian industry – with some wearing the economic cost of climate change more than others. Nationally, the worst impacted industries are service sectors (both government and business), trade and tourism, manufacturing, and mining owing to their economic structure and the distribution of the impacts of the physical climate damages over time.

Take for example, the trade industry that captures a lot of tourism related activity. Deloitte Access Economics estimates that by 2070, the industry experiences a loss of \$495 billion (in present value terms) in Gross Value Added (GVA as a measure of the industries output). This loss sees almost 190,000 jobs lost by 2070.

The weather, and the climate, is a key consideration and driver of tourism around the world. People can't have a ski holiday when there is no snow cover and can't enjoy the beach when it's over 40 degrees and humid. Climate change means such consequences will be more common, making attracting tourists – both domestic and international – harder.

As the recent impacts of the global pandemic illustrate, tourism is a pillar of many economies. Without it, many regional economies would struggle.

Tourism is one of Australia's key economic assets. Australia's tourism operators, both big and small, face changing demand preferences for travel destinations as temperatures rise.

Unchecked climate change means Australian business, jobs and livelihoods are fundamentally at stake.

The natural attractions on offer – like the Great Barrier Reef, Uluru and Kakadu National Park – underpin the success of the industry, both in terms of domestic and international demand. The Great Barrier Reef Marine Park alone in 2019 hosted 2.1 million-day visitors.¹⁷

The Great Barrier Reef is the largest living structure on Earth and is already experiencing the effects of a warming world. The IPCC estimates that climate-induced impacts to coral reefs would see a projected decline in coral reefs by a further 70–90% at 1.5°C of warming, with larger losses at 2°C.¹⁸ Taking an unmitigated pathway means the global average temperature will exceed 2°C by 2050, which could make the Great Barrier Reef a major casualty of climate change.

Indeed, a warming world and climate-induced damages will see many Australian environments become a casualty, with significant consequences for the tourism markets and regional economies that depend on them. Without the flow of tourism money circulating such economies – business, jobs and livelihoods are fundamentally at stake.

No state wants to come out on top of this list

It is not the list any Australia state wants to compete in for first prize. While all Australian states experience significant disruption due to climate change, much like covid, this disruption has different regional impacts based on the way economies are set up. A global average temperature of above 3°C by 2070 means some parts of Australia will be warmer than this, and experience even greater losses.

Queensland, Western Australia and Northern Territory have the largest losses due to a changing climate.

These states are the first to take the hit as both a consequence of their industry base, and their geography – and these losses are compounding over time. Their economies feel the brunt of warmer climates and the longer-term consequences of becoming uncompetitive against the states with comparatively cooler temperatures and industrial structures less dependent on the climate.

But these effects can be widespread, take for example – winemakers across Victoria and Tasmania. One of the oldest families

¹⁷ Australian Government (2020). [Great Barrier Reef tourist numbers](#). Great Barrier Reef Marine Park Authority

¹⁸ IPCC Special Report: Global Warming of 1.5°C (2018)

Doing nothing about climate change is a policy choice that is made. Such a choice is far from costless to the economy.

of wine in Australia, and after more than 120 years in Victoria, Brown Brothers' decided to move to Tasmania's east coast, with the company deciding that climate change was the biggest future threat to business.¹⁹

Doing nothing is not costless

Inaction or mis-action in recovery is an economic course that results in significant loss to Australia, with losses to industry, business, workers and communities at a level that disrupts the livelihoods of an entire generation. A failure to mitigate the worst effects of climate change as Australia decides on its economic future is a cost Australia cannot afford.

- **The economic costs of climate change are the baseline:** The damages from climate change are the baseline under any economic projection if climate change is not mitigated in a timely and effective way. While the scale and distribution of impacts will differ with the use of different parameters and choices, the order of magnitude of impacts are likely to show significant economic losses to Australia and the rest of the world due to unmitigated climate change.

- **While doing nothing is a choice, it is not costless:** a 'no policy action scenario' does not result in uninterrupted economic growth. A 'no policy action' pathway as the economy recovers – one that does not deliberately and rapidly mitigate climate change – results in significant economic losses. This is true in Australia, and the rest of the world.
- **There is no free ride:** as the cause of climate change is global, so too are the effects. And Australia's economic future and potential will not be isolated from the impacts of a warming world. While Australia may choose a pathway that does not mitigate climate change in line with the rest of the world, it will not be spared the economic cost if – and as – the world warms.

¹⁹ Breen, F. (2016). Rising temperatures spark 'race to Tasmania' for winemakers escaping heat. Landline, ABC, 5 June 2016

The losses to Australia's economic climate are significant

By 2070...

Western Australia

-9% in gross state product
-3.5% in employment

The industries hardest hit:

- Services
- Mining
- Trade and tourism

Northern Territory

-12% in gross state product
-5% in employment

The industries hardest hit:

- Services
- Mining
- Trade and tourism

Queensland

-14% in gross state product
-7% in employment

The industries hardest hit:

- Services
- Trade and tourism
- Manufacturing



New South Wales

-4% in gross state product
-2% in employment

The industries hardest hit:



Services



Trade and tourism



Manufacturing

Tasmania

0.5% in gross state product
0.1% in employment

The industries hardest hit:



Energy



Mining



Manufacturing

South Australia

-5% in gross state product
-2.5% in employment

The industries hardest hit:



Services



Trade and tourism



Manufacturing

Victoria

-1% in gross state product
-0.6% loss in employment

The industries hardest hit:



Services



Trade and tourism



Transport





Wind turbine, New South Wales.

Choosing change for Australia

When the problem is unconventional, so too the response. For the opportunity to realise new growth trajectories and avoid the worst costs of a changing climate, Australia requires big ideas and change.

The economic consequences and losses from unmitigated climate change are a clear cost Australia cannot afford. Australia – and the world – must recover the economy from covid differently to avoid the cost and the risks climate change poses to industries, workers and livelihoods.

Change is a constant

The global economic landscape was already one of constant change. A result of both powerful global and local forces: an ever rising Asia shifting the demand for what the world has to offer, demographic shifts unseen by current generations, the unstoppable march of urbanisation, technology and innovation, pressures and damages caused by the warming world and the unstoppable shift towards lower emissions through technology and new energy systems.

What we were experiencing pre-covid, and will continue to experience post-covid, is

change in the plural – of **the economy simultaneously trying to reconcile the impacts of globalisation, technological and environmental changes.**

While this change sees global shifts away from traditional economic dependencies and industry bases, it does not mean the end of growth or jobs in these areas. Growth and employment diversifies, or transforms entirely into new economic growth opportunities.²⁰ This is the history of economies for centuries, and the future will be no different.

Finding a resilient 'new normal'

Economies globally are addressing the same question: *how to smoothly shift off an economic baseline that was already changing, and recover to a 'new' resilient economic growth path in recovery post-covid?*

The Great Lockdown and recession may have made a dip in emissions, but this has not stopped the world from warming.

²⁰ Productivity Commission (2017), *Transitioning Regional Economies*, Australian Government: December 2017

A targeted new growth recovery will tick many boxes for the Australian economy – providing jobs in high-growth industries, investment in Australia’s infrastructure, technological progress and emissions efficiency in traditional sectors, and the creation of export opportunities for Australia – all while mitigating climate change domestically.

The short-term emission reductions from covid related restrictions are almost negligible in in the long-term. Such a level of reduction would need to occur almost annually to shift the dial on climate change. This means that lasting effects will only arise if economic recovery strategies for the long-term are characterised by systematic action and decarbonisation of the economy.²¹

The unprecedented global health crisis brings unprecedented opportunity

Both government and private sector investment is needed for economic recovery to fill the chasm covid has left in the economy. The global economy is at a fork in the road – and policymakers’ most important task is to reduce uncertainty while providing economic relief and stimulus to the hardest-hit sectors and individuals.

This focus must be used to accelerate Australia’s inevitable shift to a low emission economic structure. A shift that will create a new and resilient economic growth path in recovery.

Creating a new growth recovery

A new growth recovery that mitigates climate change will be in line with existing targets and the world’s renewed enthusiasm to invest in resilient economic pathways. Most global economies are seeking to reach net zero emissions by 2050, if not sooner, limiting global average warming to 1.5°C above pre-industrial levels – and Australia has to keep up if it is to remain competitive.

While a net zero emission pathway for Australia requires a structural and economic adjustment, **the shift can be embodied by deliberate and balanced actions taken towards the development and deployment of lower emission technologies and processes across the economy.** This change will be incentivised and supported by both government investment and backed by private capital. These investments are not only right type of fiscal stimulus needed today but are the investments that secure long-term economic growth in Australia.

New growth that provides good jobs, productivity in all the right places and deliberate disruption – out with the old drivers of growth and in with the new – is Australia’s climate for growth.

²¹ Forster, P.M., Forster, H.I., Evans, M.J. et al (2020). Current and future global climate impacts resulting from covid-19, *Nat. Clim. Change*

A new growth future is not dreamland. Any structural adjustment to an economy has challenges. But the technologies, policy options and ideas to create new growth in Australia are available today – Australia needs to choose to change and get on with it.

Australia's climate for growth requires investment in the new drivers of growth that will build up Australia's traditional economic base to be diversified effectively, remain competitive and put the existing skills of workers to work in well-paid jobs.

Make the switch

Technological progress and emissions efficiency are at the heart of achieving net zero emissions for an economy. It determines how hard and how fast technological change is embedded in the economy to drive emissions reduction for businesses, industry and households, and how this reduces the cost to the economy of achieving emissions targets.

- Renewables were recognised as an important part of the effort to reduce emissions 30 years ago. However, there was also scepticism over the role they could play in the short term given their relatively high-cost, intermittency, and the level of investment that would be required to achieve widespread adoption.
- Fast forward to the present and advances in renewable electricity generation technologies, like solar and wind have brought their

price down making complete or near decarbonisation of the grid a possibility. Indeed, over the past decade, the demand for electricity has grown. Much of this additional demand has been successfully met by renewable sources.²²

- The continuing uptake of renewable energy in Australia – spurred by policy support, falling costs and increasing cost competitiveness – will help decouple the electricity grid from emissions intensive activity. Such change wouldn't just lower electricity emissions, it is also the cornerstone of decarbonisation across other sectors in the economy, such as transport, much of Australian industry and Australia's fugitive emissions, to further the emissions efficiency impact.
- The generation of renewable energy is a mature technological solution, and while on-going developments must continue to account for intermittency (i.e. in large-scale battery storage), it is well-positioned for widespread deployment.²³ The timing has never been better to consider the future of Australia's energy infrastructure and invest in the switch.

²² Climate Works (2020), *Decarbonisation Futures: Solutions, actions and benchmarks for a net zero emissions Australia*

²³ Climate Works (2020)

There is large export potential for Australia as the low emission transformation occurs globally. Change creates the opportunity for new jobs and new industries, but only if Australia chooses to change today.

The world must want what Australia has

A decisive and timely economic transformation to net zero emissions presents an opportunity for Australia to emerge as globally competitive in a low emissions world.

Australia is a historically emissions intensive, and resource-rich trading nation – and actions taken by our global trading partners have a large bearing on the domestic economy. If Australia continues along an emissions intensive economic trajectory while the global economy is taking strong mitigation action, Australia's current competitive advantages will end.²⁴

But **Australia doesn't have to lose advantage in a low-emissions world.** By choosing to change to a new growth path and seizing the opportunity in front of us, Australia's covid recovery trajectory can be resilient to the economic impacts of a warming world and economic disruption.

Where Australia is currently a major exporter of energy, in a global economy where emissions intensive energy is replaced by energy from renewables, Australia can be a global source of secure and reliable renewable power. Countries such as Japan, South Korea and Germany have already come to Australia asking for us to export renewable hydrogen for their own domestic energy consumption.²⁵ The opportunity to remain competitive and make sure Australia has what the world wants is there.

²⁴ Garnaut, R (2019), Super-power: Australia's low-carbon opportunity, La Trobe University Press

²⁵ Garnaut, R (2019)

Big – but not new – ideas for a new growth recovery

For the opportunity to realise new growth trajectories and avoid the worst costs of a changing climate, steps must be taken by global and individual economies alike.

The good news? **Most of the big ideas that create the change required to grow Australia’s economy in recovery, while mitigating climate change, already exist.**

Deloitte Access Economics sees several characteristics that define a new growth recovery in Australia:

- **When the problem is unconventional, so too the response:** Fiscal recovery policies that mitigate climate change have advantages over traditional fiscal stimulus that better suit the problems of this crisis. Take the issue of needing to address unemployment now, while equally maintaining public health measures and social distance. There is a time lag, a mismatch and big health and safety trade-offs. But looking to renewable energy, it generates more jobs in the short run during construction when jobs are scarce in the middle of a recession. This lifts spending and increases short-run economic

growth multipliers. Over the long-run, renewables require less labour, but this frees up labour just as the economy returns to capacity and the dividends of other job-creating policies bear fruit.

- **Get the baseline right and define the economic endgame:** There are many calls for economic reform to drive Australia’s covid recovery. But there is inconsistency and confusion in the discussion from different sectors, or regions, on what the calls to reform are for – and what the economic endgame is. Whether it is the view of business, government or communities, there needs to be a unified view on the economic baseline going forward, and that the baseline includes structural change, transition and new global demand profiles – whether from climate change or other global forces. **Getting the baseline right requires an acceptance that the future is fast moving and dynamic – and decision making must keep up with this.** Where the baseline is understood, the economic endgame must also be defined. Growth for growths sake is not a recovery pathway that will provide the resiliency and outcomes that Australians crave.

A new growth recovery creates the opportunity to remain competitive and make sure Australia has what the world wants.

- **Smoothing the inevitable transition:**

Low emissions growth doesn't stop with renewables. There are countless other low emission and future-proof infrastructure investments to be made, such as grid modernisation, storage (importantly including hydrogen) and the electrification of Australia's urban areas all offer returns. Public investments – in their own right or alongside private investment – will reduce the costs of the inevitable economic transition to a low emission world and support Australia's ability to maintain competitive advantages.

- **Shovels and strategies are ready:**

most states and regions have net-zero emission economy or emission reduction target – and pre-covid, 2020 was on track to be catalytic for the private sector push to mitigate their businesses and balance sheets against the risks from climate change. This means many projects, investments, infrastructure and plans are 'shovel ready' to roll out as it is safe to do so. From energy efficiency retrofits of commercial buildings to developing green space – and transforming entire industries to net-zero emissions. Projects and strategies exist to support employment, and the incentives are there:

capital is cheap, investment is needed, and the world wants it. All that's left is the will and the way...or, in some instances, for governments of all levels to get out of their own way.

- **Targeting the training system:**

Reducing unemployment and securing standards of living will be the major focus of any government policy action in recovery – and rightly so. Where large investments in education and training are made to address employment impacts from covid, they can equally be targeted to address existing economic disruption and future risk from inaction or mis-action on climate change. All workers have valuable skills, knowledge and experience which are transferable to other areas of the economy as it changes. Australia's recovery must ensure that these skills are put to good use. Setting, and investing, in an economic recovery pathway that maximises traditional economic strengths, and the skills of today's workers, is critical to ensuring workers are prepared for a low emission economy.

Australia's climate for growth is the opportunity to remain competitive and make sure Australia has what the world wants.

What creates a new growth recovery?



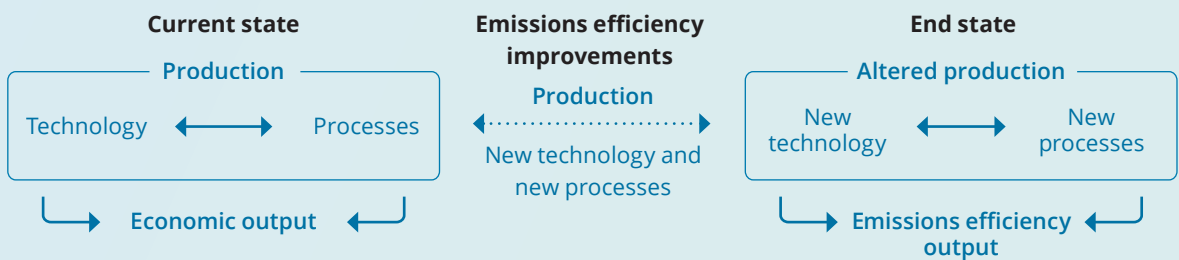
Energy system transformation and fuel switching

The decarbonisation of the electricity grid is a key enabler of fuel switching across the economy, and within industries, as firms and households substitute away from emissions-intensive fuel sources towards renewable electricity.



Technology advances driving emissions efficiency

Emissions efficiencies required for a net zero economy are driven by technological innovations; a result of incentives produced by a concerted effort by government to support a net zero transition.



A global sustainable recovery

Policy makers around the world have a once-in-a-lifetime opportunity to simultaneously boost economic growth, create sustainable jobs, build more resilient and cleaner energy systems and to steer global emissions into structural decline.

By 2070...

\$680 Billion
and 250,000 jobs

New South Wales

2% growth in GSP

Over 50,000 jobs added

NSW has a complex path to new growth. But gains in manufacturing, tourism, transport and services grow after net zero is reached.

Queensland

5% growth in GSP

Over 185,000 jobs added

QLD suffers irrevocable losses from climate change. As a diversified economy, new growth offers relief from climate damage and opportunity in manufacturing, transport, services and saves tourism jobs.

Victoria

2% growth in GSP

Over 30,000 jobs added

VIC has less to gain in new growth as it has less to lose from climate change due to its location. Strong job growth in renewables, transport and services shape the economy.

Tasmania

3% growth in GSP

Around 10,000 jobs are not additionally created

TAS sticks out as a relative 'winner' as the world warms due to its colder climate, making it a relative 'loser' in new growth. But it is still growing. Just relatively less as it has less to lose from climate change. This is a good thing.

South Australia

5.3% growth in GSP

Over 150 jobs added

SA sees job growth in renewables, construction and services - but high employing industries like tourism and agriculture still feel damages of 1.5°C.

Western Australia

1% growth in GSP

Around 10,000 jobs are disrupted

WA continues to structurally adjust from a concentrated resource-based economy.

Northern Territory

5% growth in GSP

Over 5,000 jobs added

NT has a lot to lose from climate change. New growth offers jobs in industries like manufacturing, tourism and transport.

Australia always has and always will be an economy made up from the strength and diversity of its states, regions and endowment of natural resources. This can be true as regional economies adjust in transition, but only if we choose change today.

A new growth recovery in Australia

Like any economic change, simultaneously delivering a new growth recovery and a net zero economy can be susceptible to the challenges of structural adjustment. No adjustment of this scope and scale is without complexity – but decisive and collectively agreed efforts to make the change can generate a positive return for economies like Australia’s in a relatively short timeframe.

And it is this decisive change that can take Australia from strength to strength, particularly where economic recovery repairs the damage inflicted by the pandemic, while putting the economy on a strong future footing.

Taking Australia from strength to strength

A new growth recovery for Australia delivers a system-wide transformation of Australia’s energy sector to meet net zero emissions; the adoption of technology across all sectors creating emissions efficiency; and global fiscal policy settings establish a sustainable and net zero recovery. These domestic and global transformations result in fuel switching to renewable sources, investments in technology that create productivity gains and higher long-term economic output.

As this transformation occurs, Australia’s traditional economic strengths begin to adjust – some industries such as mining and agriculture are forced to adjust as the world does not want what we traditionally have. But the diversity and strengths of Australia’s economic fundamentals supports structural adjustment to reach net zero by 2050. After all, Australia’s mining industry is bigger than coal.

And once Australia makes the change, the economic gains of a new growth recovery take shape.

Net zero is an economic necessity

The cost to Australia of a global failure to deliver a new growth recovery is -6% of GDP and over 880,000 jobs are lost by 2070. Compared to this dismal future, Deloitte Access Economics estimates **a new growth recovery grows Australia’s economy by \$680 billion (present value terms) and increases GDP by 2.6% in 2070.** This new growth path adds **over 250,000 jobs by 2070.**

These are the gains, the opportunity, for Australia by being one of the countries around the world reaching net zero emissions, sooner rather than later, to limit global average warming to 1.5°C above pre-industrial levels.

While over 250,000 jobs are added to the Australian economy by 2070 under a new growth recovery, over 880,000 jobs could be lost due to unanswered climate change.

This would not just be an achievement of a target or goal for Australia. Limiting warming to 1.5°C above pre-industrial levels, or no greater than 2°C, by 2050 is an economic must. A new growth recovery sees Australia's economy growing and the creation of employment – where it otherwise is experiencing losses the likes of which covid can only compare. **Australia being part of – if not leading – the global shift to net zero in a new growth recovery is in the national interest.**

What if we could pay today to stop the next great recession?

A net zero future, even limiting global average warming to 1.5°C by 2050, does not mean the world is climate change or damage free. With each passing year as emissions increase and global average warming with it, Australia still feels the heat. There is an amount of **economic loss in Australia due to climate change that is now 'locked in'**.

In a new growth recovery, Australia is still feeling the effects of 1.5°C of global average warming and Australia's economic structure is adjusting to reduce emissions intensity with the rest of the world. This creates **a twofold economic effect: damages occur with any degree of warming to 2050, and the adjustment costs in**

the economy of mitigating this damage is worn as the transition to net zero occurs.

The economic costs of the 'locked in' global average warming that occurs and moving to net zero by 2050 is a 0.1% loss in GDP growth, on average, over the 30 years to 2050. This 0.1% loss in Australia's GDP by 2050 is estimated to be \$90 billion, in present value terms. But of this cost, 26% is due to locked in damages from a warming world.

The remaining \$67 billion, by 2050, represents the cost to the economy of reducing emissions to reach net zero in a new growth recovery.

A \$67 billion economic cost to transform the economy by 2050 is a small price to pay, relative to the size of our economy. In dollar terms, **for comparison, the current JobKeeper program is costing the federal budget just over \$65 billion this year alone** – and this is the necessary price Australia is paying to minimise the worst economic consequences of covid.

If we could spend today to prevent the next great recession from climate change, why wouldn't we?

A new growth recovery is old-fashioned risk management – and good fiscal management.

Time to get on with it

Australia can choose a long-term economic pathway that delivers reduced emissions and offers resilient economic growth.



There is no winner in a warming world – but there are economic choices that minimise the downside and kickstart the upside.

There is a high price for Australia to pay from doing nothing

Unchecked climate change in Australia, creating a \$3.4 trillion loss to Australia's economy by 2070, is a cost we clearly cannot afford. And **where the cost of complete inaction is so high, delayed action is also very costly.**

This warming world is no joke. It will affect our ability work outside – building houses and infrastructure that we critically need. It affects our choices on where to live and holiday – as sea level rises and riverine flooding increase in intensity and impact. It affects our ability to play – hotter days means less outdoor playtime. We could even see the death of the Boxing Day Test and weekend club sport if things go on unchecked. *That is a loss of the Australian way of life.*

These costs are further compounded by Australia not keeping up with the rest of the world as it responds to climate change. There is no winner in a warming world – but there are economic choices that minimise the downside and kickstart the upside.

Australia needs 'good' economics to recover from covid

In thinking about what a post-covid world looks like, there has been discussion on the need for 'green growth' and 'green recovery' policy – decisions that recover economies from covid, while mitigating the worst consequences of climate change and unsustainable economic structures.

There is no need for green, just good. As Australia cushions the economy to the effects of the pandemic and recovers, there is a need to think of resilient investments for recovery: this is what most risk managers would simply call 'good' investments.

And a cost seen by some, is an investment to others. It is not about 'green' investments or policy, it is about what is good – good policy, good economics and good investments that mitigate risk and creates returns to both business, industry, society and the economy.

Becoming net zero is in Australia's national interest

Australia alone cannot stop global climate change – and nor should it. **But Australia has the most to gain from first mover advantages to transition to a low emission economy,** and the most to lose economically from delay. This is where the 'good' economics comes in.

Creating new growth in recovery can reduce emissions and solve for existing economic disruption already occurring – skills shortages, mismatches in regional labour markets, ailing productivity, low (or no) wage growth, and shifting global demand for what Australia has to offer.

Australia's economy could be \$680 billion larger in 2070 – adding over 250,000 jobs – by being a country that reaches net zero emissions, sooner rather than later, to limit global average warming to 1.5°C along with the rest of the world. Australia being part of – if not leading the way – in the global shift to net zero in a new growth recovery is in the national interest.

In this together

An economic feature of climate change is the shared nature of the problem – the climate does not care about

geographical borders, geopolitical postures, or for ideological reasoning.

The shared nature of the climate means that while take steps can be taken to prepare for the risks of climate change – and to seize the opportunities of new markets that tackling climate change offer – the ultimate solution is co-ordinated global action.

The reality for Australia is that we stand to lose the most from unanswered climate change, but also stand to gain significantly from action. For a middling diplomatic and economic power, Australia has every incentive to drive the global agenda for the national interest.

The analysis in this report is foundational to serving that purpose. The delayed COP26 forum in 2021 is critical for driving global action and steering economic recovery towards a resilient global economy. Where Australia's States and Territories can be armed with the analysis of the impact of climate change on their geographies and sectors – and the alternative pathways each want to pursue – along with the Australian Government, Australia can quickly develop a strategy. This policy work is the bread and butter of governments at all levels – there are no excuses.

Equally, this can be true for business. The analysis shines a light on the impacts of climate damages and the benefits of a new growth recovery. This helps define the economic endgame that industry sectors need to play at to get their decarbonisation plans underway – because without an economy wide view, it is difficult to gauge the extent to which a sector or an organisation needs to play in reducing emissions.

In times of great uncertainty, defining and realising the scenarios that mitigate the greatest risks to economic and social life is more critical than ever before. This report provides a basis for business, industry and government to further consider such scenarios – to develop sector and business targets, to drive a policy and regulatory approach for a balanced transition of the economy and building resilient growth and jobs for the future.

It is the nature of the problem that its solution is found together, or not at all. Australian's have already had enough risk for this decade – it is time to choose change to make life easier for us all. It is time to get on with stopping climate change and creating Australia's climate for growth.

Choosing change checklist:



1. Most to lose, most to gain:

Australia needs to drive the global agenda for action to mitigate climate change in the national interest.



2. What gets measured, gets done:

Australian governments need to understand the impact of climate change on their geographies and sectors. Understanding impact is the foundation for decision making.



3. Get on with it:

Business, industry and government need sector, organisation and economy-wide strategies to reach net zero emissions by 2050.



Cape Peron at sunset, Shark Bay, Western Australia.

Technical Appendix

Emissions intensive employment

Deloitte Access Economics' uses in-house modelling and the National Emissions Inventory 2018 by economic sector²⁶ to determine the distribution of emissions intensive employment in Australia and across industries.

Carbon dioxide equivalent emissions are mapped to industry employment, using the ANZSIC 2-digit level, noting some sub-industries are not available for reasons of confidentiality. As a consequence, some industries present as greater than the sum of their available parts.

The distribution of emissions by industry informed the classification of the emission intensity ranges: from Extremely Intensive as the highest, to Marginally Intensive as the lowest. Table A.1 below shows the ranges of carbon dioxide²⁷ emissions, measured in Gigagrams (Gg).

Each industry falls into one of the above ranges, based on the emission levels of the industry. Table A2 below shows the industries within each emission intensity range.

Table A.1 Emission intensity ranges

	Emission intensity ranges (Gg)	
Marginally Intensive	—	1,000
Moderately Intensive	1,001	4,500
Intensive	4,501	13,000
Highly Intensive	13,001	30,000
Extremely Intensive	30,000	30,000+

Source: Deloitte Access Economics modelling using Australian Bureau of Statistics ANZSIC classification and the National Emissions Inventory 2018 Economic Sector classification.

26 ANZSIC 2-digit codes, noting some sub-industries are not available for reasons of confidentiality. As a consequence, some industries present as greater than the sum of their available parts.

27 Comprised of Carbon Dioxide, Methane, Nitrous Oxide and Other.

Table A.2 Emission intensity ranges by industry

Marginally Intensive	<ul style="list-style-type: none"> • Professional, Scientific and Technical Services • Manufacturing (Fabricated Metal; Textile / Leather / Clothing / Footwear; Transport / Machinery / Equipment; Furniture) • Aquaculture • Fishing, Hunting and Trapping • Agriculture, Forestry and Fishing Support Services • Arts and Recreation Services • Other Services.
Moderately Intensive	<ul style="list-style-type: none"> • Manufacturing (Food Product / Beverage / Tobacco) • Wholesale and Retail Trade • Rail Transport • Accommodation, Food Services, Education and Health Services • Gas Supply • Water Supply, Sewerage and Drainage Services • Finance, Insurance, Rental, Hiring and Real Estate • Forestry and Logging • Wood, Pulp, Paper and Printing • Building Construction • Information Media and Telecommunications • Heavy and Civil Engineering Construction.
Intensive	<ul style="list-style-type: none"> • Metal Ore and Non-Metallic Mineral Mining and Quarrying • Manufacturing (Basic Chemical/ Polymer/Rubber; Non-Metallic Mineral Product; Petroleum and Coal) • Waste Collection, Treatment and Disposal Services • Air and Space Transport Administration, Public Administration and Services • Construction Services • Other Transport, Services, Postal and Storage.
Highly Intensive	<ul style="list-style-type: none"> • Manufacturing (Primary Metal/Metal) • Road Transport.
Extremely Intensive	<ul style="list-style-type: none"> • Electricity Supply • Agriculture • Oil and Gas Extraction • Coal Mining.

Source: Deloitte Access Economics modelling using Australian Bureau of Statistics ANZSIC classification and the National Emissions Inventory 2018 Economic Sector classification.

Industry employment numbers, from Deloitte Access Economics' modelling, at the regional SA4 level has been used to calculate the number of jobs in each emission intensity range, within each SA4 region.

The degrees of intensity map in Chapter 1 shows the

employment numbers in the highest three emission intensity ranges – Intensive, Highly Intensive and Extremely Intensive – as a proportion of total employment within each SA4 region. The distribution of these emissions intensive employment proportions informs the colour legend of the heat map (Table A.3).

Table A.3 Emission intensity ranges

	Emission intensity ranges (Gg)	
1	0%	15%
2	15%	30%
3	30%	45%
4	45%	60%

Source: Deloitte Access Economics modelling using Australian Bureau of Statistics ANZSIC classification and the National Emissions Inventory 2018 Economic Sector classification.

Deloitte Access Economics' views and approach to modelling damages from climate change as the baseline

To date, most macroeconomic models and economic policy modelling is done on a 'baseline' that assumes economic growth will occur unhindered by the increasing emissions intensity of economic output.

Models inherently assume that as emissions grow, the economy grows, and everyone's standard of living rises. Deloitte Access Economics believes this viewpoint does not hold true in practice – particularly in the long-run – and therefore economic analysis and public policy making is informed through a dated theoretical framework.

Climate change impacts should not be imposed as a 'scenario' on the baseline – because in the absence of fundamental societal and economic shifts, it is the baseline.

To leave the economic impacts of a changing climate out of economic baselines and decision making misses a trick. The Network of Central Banks and Supervisors for Greening the Financial System (NGFS), made up of 69 central banks including the Reserve Bank of Australia (RBA), this year released guidance the need to solve for this exact issue (and many others). Understanding and accounting for the longer-term effects of climate change on productivity, potential output and economic growth is critical to knowing the path of growth, and the distribution of the impacts of disruption.

Deloitte Access Economics has significantly invested in developing an in-house Regional CGE Climate Integrated Assessment Model (DAE-CLIMATE). DAE-CLIMATE – which has been tested in Australian state jurisdictions – is a modelling method and policy analysis

technique that seeks to 'correct' the typical business as usual baseline in modelling.

DAE-CLIMATE is built on an economic modelling framework that accounts for the economic impacts of climate change and establishes a reference case, which can be modelled for policy analysis out to the year 2100. The DAE-CLIMATE process and logic is summarised as follows:

1. Modelling a projected economic output (as measured by Gross Domestic Product) which causes emissions to reflect a Representative Concentrative Pathway (RCP) ranging between RCP6.0 and RCP8.5.²⁸
2. Increased concentration of emissions causes global warming above pre-industrial levels.
3. Warming causes anthropogenic climate change and results damages to the factors of production.
4. These damages to the factors of production are distributed across the economy, impacting Gross Domestic Product.

To translate this concept into a modelling process, it involves understanding three models which link to each other through three key outputs. Deloitte Access Economics' approach extends methods adopted by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), the International Panel on Climate Change (IPCC) and academia. The method is extended by necessity for practical public policy purposes and our modelling is regionalised – allowing results and insights to be produced at the regional level (such as Australian Bureau of Statistics statistical areas or local government boundaries).

The modelling process is summarised below:

1. Deloitte's in-house regional Computable General Equilibrium model (DAE-RGEM) is used to produce a projected path for economic output and emissions that align to reflect a decided RCP range between RCP6.0 and RCP8.5.
2. This emissions pathway is modelled in our climate change model (Model for the Assessment of Greenhouse Gas Induced Climate Change – MAGICC) for the assessment of the physical damages which follow from projected shifts in global and regional temperatures.
3. These then feed into a damage function to inform how shifts in temperature may play out in terms of impacts on the productivity of labour and capital in each sector/region. Unlike most other models, we model a broad range of damages, including capital damages, sea level rise damages to land stock, heat stress damages on labour productivity, human health damages to labour productivity, agricultural damages from changes in crop yields, tourism damages to net inflow of foreign currency and damages to energy demand.

Deloitte Access Economics has also invested and developed techniques to extend DAE-CLIMATE results into our macroeconomic and labour market modelling.

²⁸ IPCC scenarios without additional efforts to constrain emissions ('baseline scenarios') lead to pathways ranging between RCP6.0 and RCP8.5.

DAE-RGEM

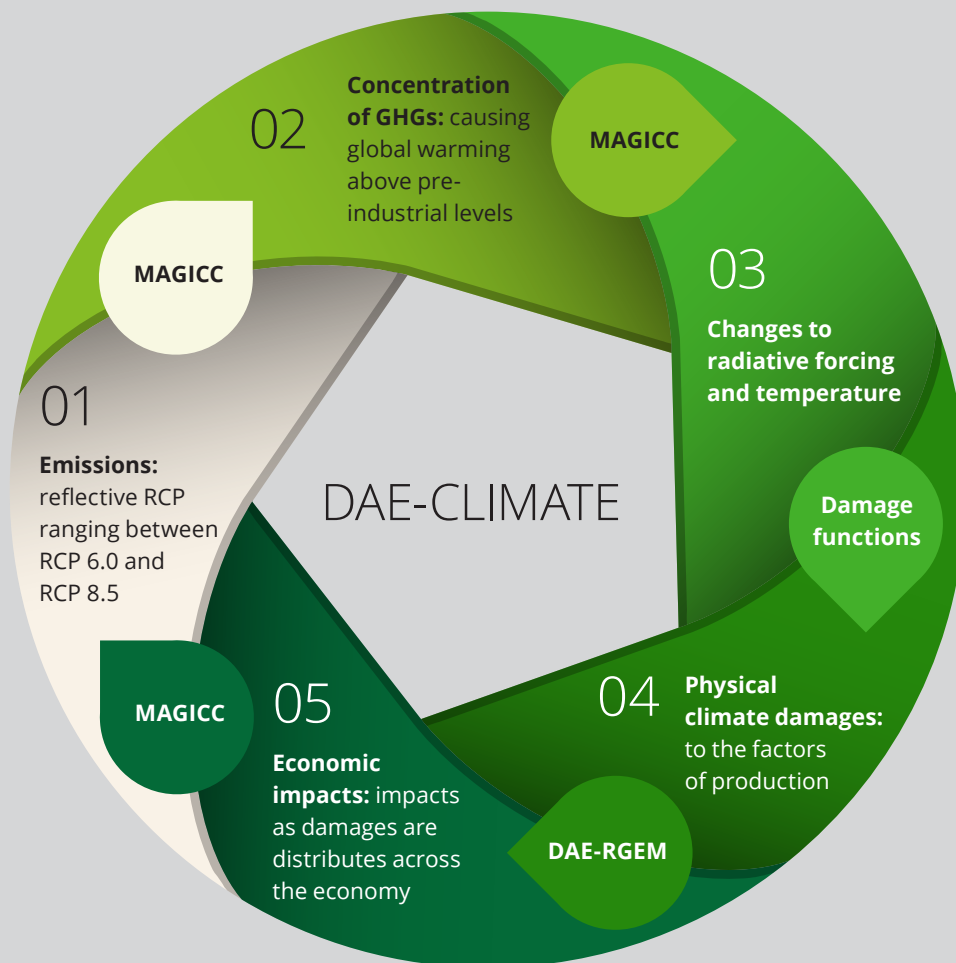
Our in-house CGE model is used to produce a projected path for economic output and emissions that align to reflect a decided RCP range between RCP6.0 and RCP8.5. Our model has a calibrated **emissions database**.

MAGICC

Is a peer reviewed climate model which takes the projected change in emissions from DAE-RGEM and produces a projected change in temperature. The physical **changes from MAGICC are calibrated as an input** into DAE-RGEM which is then translated into damages.

Damage functions

Are used to translate a given temperature increase into economic damage by sector, region and over time. The parameters of the **damage functions are an input**, developed by DAE in consultation with climate science experts and translated to regionalised economic impacts.



The loop

Macroeconomic forecasts can also be calibrated back into DAE-RGEM to generate a new emissions starting point – for example, a new macroeconomic baseline including covid-19 impact. Noting, as DAE-CLIMATE runs to 2100, trend and timing are the greatest consideration here.

Macroeconomy

The regional changes in economic outputs and structures as dictated by DAE-CLIMATE under a damages baseline and mitigation scenarios can be translated into macroeconomic changes. This is used to forecast a consistent macroeconomic view and scenarios – for example, macroeconomic forecasts and labour market forecasts accounting for damages or a net zero emissions economy to 2050.

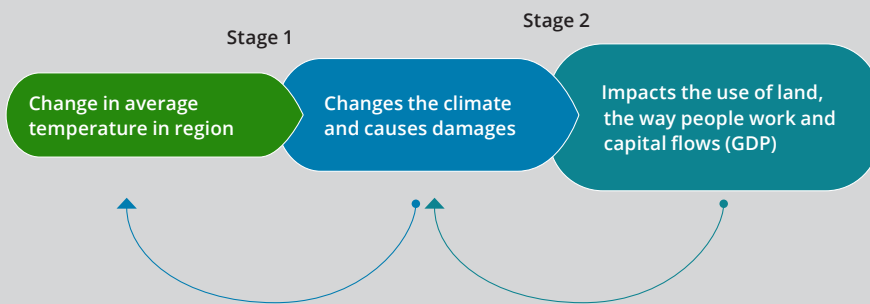
Temperature as the fundamental driver of damages

The fundamental ‘driver’ of economic damages is rising temperature. As rising temperature induces climate change, economic output (as measured by GDP) is impacted through the physical damages that affect productivity and / or stock of factors of production (Figure A.1).

Heat stress damages on labour productivity

Workers can often feel uncomfortably hot during their working hours, particularly those heavily exposed to the heat and sun. Think of the farmers working out in the paddocks under the harsh Queensland summer sun, or those working where air-conditioning isn’t available.

Figure A.1 ‘Two-stage’ economic damages relationship



Source: Deloitte Access Economics

As temperature continues to rise, hotter working environments become the new normal and heat stress on workers surpasses the point where it is only a concern of comfort levels; it becomes a concern for the health and safety of workers and their ability to perform tasks.

Heat strain and heat stroke can have serious health consequences, and they are also important factors when considering labour productivity.^a

Climate change will see rising temperatures but also the shift of the distribution of daily peak temperatures and relative humidity, making heat waves more frequent and extreme.^b

While acclimatisation and adaption are all factors to be considered, physiologically, there is only so much heat stress the body can take. When the human body is physically working, heat is produced internally and needs to be transferred to an external environment, to avoid body temperature increasing. If body temperature exceeds 39°C, heatstroke can develop, and a temperature of 40.6°C can become fatal. Before these serious health consequences are reached, at lower levels of heat exposure, workers are subject to diminished mental task ability, diminished capacity to work at their former level and a higher risk of accident.^c

This study includes six regionalised damages to Australia:

1. Heat stress damages on labour productivity
2. Human health damages to labour productivity
3. Sea level rise damages to land and capital stock
4. Capital damages
5. Agricultural damages from changes in crop yields
6. Tourism damages to net inflow of foreign currency.

The following section outlines each damage and how they impact the economy.

When faced with higher levels of heat exposure, a worker will instinctively react to reduce their work intensity and/or increase the number of breaks taken. Some workplaces, under occupational health management interventions, may even enforce a reduced work intensity. This 'slowing down' of work results in reduced 'work capacity' and lower labour productivity.^d

When considering the different level of heat-exposure and labour intensity across sectors, the impacts on labour productivity will vary. Those working in agriculture and manufacturing will be more exposed to heat stress and resulting reduced levels of work capacity compared to those working in services sectors.

It is in such ways that heat stress is considered a significant damage to labour productivity and is incorporated into this study.

Human health damages to labour productivity

The impacts of climate change on human health are many and complex.^e Increasing temperatures can increase both heat and cold-related health problems, particularly those with pre-established cardiovascular and respiratory disorders.^f

Climate change can impact the range, abundance and spread of species carrying diseases. Studies show that the prevalence of mosquito-borne malaria will increase as temperatures rise, and other vector-borne diseases may increase or decrease.^g Developing countries, and those with immunologically-naïve populations and unprepared medical systems will bear the brunt of the spread of diseases; with food-and waterborne diseases (e.g. cholera and diarrhoea) potentially being the most problematic.^h

As extreme weather events become more severe and frequent, so does the risk of floods and storms killing and injuring people. Climate change can affect air quality, and all diseases resulting from air pollution – the recent summer of bushfires in Australia was a stark reminder of this. Climate change may also affect human health indirectly, through changes in food production, water resources, migration and economic development.ⁱ

This study considers an increased incidence of mortality and morbidity on the working population, and the associated reduction in number of hours worked, resulting in lower levels of labour productivity.^j

Sea level rise

As temperature continues to rise and the world continues to warm, land-based glaciers are melting, and water bodies are experiencing thermal expansion. These factors combined cause the phenomenon of sea level rise (SLR).

SLR affects the land stock (an economic factor of production) through the erosion, inundation or salt intrusion along the coastline.^k The share of land which may be lost depends on several country-specific characteristics, such as the composition of the shoreline (cliffs and rocky coasts are less subject to erosion than sandy coasts and wetlands), the total length of the coastline, the share of the coast which is suitable for productive purposes (i.e. in agriculture or urban land), and the vertical land movement.^{l,m}

As productive land is lost through SLR, so too is the level of productive activity on the land. Agricultural output will be impacted by erosion, inundation or salt intrusion.

In low lying and seacoast urban areas, residential and commercial properties will incur physical damages and require significant capital costs for repair. As the risk of physical damage becomes too high, and the cost of insurance becomes unobtainable, migration inland of low-lying communities may occur. The residential sector will see sharp property value adjustments.

Capital damages

This study considers in addition to sea level rise, the increased frequency and intensity of extreme weather events that likely cause damage to capital, including dwellings, infrastructure and machinery and equipment. The climatic events that cause capital damages in this study include riverine flooding, forest fires, subsidence, high wind speeds (excluding cyclones) and extreme heat.

The methodology is based upon data produced by XDI modelling of climate change impacts on Australia's physical capital stock.ⁿ The estimated damages produced by this research can be interpreted as a percentage of annual capital investment that is diverted to repair and replace damages assets.

Including capital damages in this way represents the largest departure from existing economic impact modelling and integrated assessments of climate change. In some cases, capital damages are included but at a highly aggregated level that limits regional analysis. The availability of XDI data provides a unique opportunity to include this damage function that can be specified using cutting edge probabilistic climatic-spatial modelling of the Australian capital stock.

International capital damages are scaled based on data from 'The International Disaster Database' (EM-DAT) managed by the Centre for Research on the Epidemiology of Disasters (CRED).

There is large export potential for Australia, as the low emission transition occurs globally, providing the opportunity for new jobs and new industries; but only if Australia *chooses change*. There are opportunities for Australia's exports if we export the same amount of energy globally, except in the form of renewable energy.

Data on the economic cost of climate-related natural disasters is used as a proxy for exposure to capital damaging climate change for developed and developing countries relative to Australia.

Despite the inclusion of this damage estimate, it is noted that the exclusion of the most extreme natural disasters from this study – due to extreme ranges to the end of the century – ensures that the damage estimated included can be considered conservative.

Agricultural damages from variations in crop yields

The agricultural sector is on the front line of climate change in Australia. Australia's vast and variable geography means that one part of the country can be suffering from the worst drought in living memory, while other parts are experiencing devastating floods. These extremes can even happen simultaneously within Australia.

Climate change means rising temperatures, higher concentrations of carbon dioxide (CO₂) in the atmosphere and different regional patterns of precipitation.⁹ For agricultural production, this means fluctuations in growing conditions, water availability and the severity and frequency of extreme weather events; resulting in crop yield volatility and market uncertainty.^p

But there are many factors at play when looking at the impacts of climate change on agriculture. Varying levels of agronomic and economic adaption exists in the agricultural sector; farmers can adjust crop rotation, crop selection, sowing times, how they grow a particular crop, the amount of fertilisation due to higher CO₂

concentration and the actual level of water available for irrigation, and irrigation techniques.^{q,r}

When faced with unmitigated climate change, even with adaption, there are limits to what farmers can do. This study considers damages to agriculture as variations in crop yields to be a significant impact.

Tourism damages

The weather, and the climate, is a key consideration and driver of tourism around the world. People can't have a ski holiday when there is no snow cover and can't enjoy the beach when it's over 40 degrees and humid. Climate change means such consequences will be more common, making attracting tourists – both domestic and international – harder.

As the recent impacts of the global covid-19 pandemic illustrate, tourism is a pillar of many economies. Without it, many regional economies would struggle.

Tourism is one of Australia's key economic assets. The natural attractions on offer – like the Great Barrier Reef and the Daintree Rainforest – underpin the success of the industry, both in terms of domestic and international demand. The Great Barrier Reef Marine Park alone in 2019 was hosted 2.1 million-day visitors.^s

The changing climate will see these environments become a casualty, with significant consequences for the tourism markets and regional economies that depend on them. Without the flow of tourism money circulating such economies – business, jobs and livelihoods are fundamentally at stake.

Valuing the future

It is inherently difficult to 'discount' the future, particularly concerning an issue as socially and economically complex as climate change. But it is important to recognise the intergenerational impact of climate change and in doing so, account for the tendency of people to preference short term economic flows over longer term-flows. The question becomes, what discount rate is appropriate to embody these preferences?

Greenhouse gas emissions have a long residence time in the atmosphere, which means that the value of the impacts of today's emissions must be considered for future generations:^t

- The use of a **high discount rate** implies that people put less weight on the future and therefore that less investment is needed now to guard against future costs – meaning we would be kicking the can down the road.
- The use of a **low discount rate** supports the view that we should act now to protect future generations from climate change impacts. In other words, more importance is given to future generations' wellbeing.^u

A discount rate of 2% has been used by Deloitte Access Economics in this analysis, after considering the differing perspectives within the literature. The results of a survey of economists (the sample contains over 200 academics who are defined as experts on social discounting by virtue of their publications), published in 2015, indicates that most favour a low discount rate: with more than three-quarters comfortable with a median discount rate of 2%.^v

RCP8.5 for modelling in DAE-CLIMATE

In recovering from the impacts of covid, the long-term pathway of growth is one that includes a changing climate. And if this change is unanswered the physical damages of a warming world will take effect.

In an economic future where Australia and the rest of the world does not mitigate the worst effects of climate change, the world has an emissions pathway that reflects RCP8.5. This gives Australia an economic and emissions profile that produces global average warming of above 4°C by 2100.²⁹

As the global temperature gradually increases to the end of the century, Australia feels the heat.

What is more likely, is that there is a range of possible ‘no policy action’ baseline outcomes, and the majority of which would result in lower future emissions as technology generally improves, supply chains get more efficient and renewable energy increases in its cost competitiveness overtime (for example).³⁰

This report has used RCP8.5 to understand and calibrate the unmitigated damages baseline in Australia for several key reasons:

- The economic outcomes that occur globally, and in Australia under these parameters most appropriately reflects a ‘no policy action’ scenario that is most suited to act as the reference case for other specified policy actions that may mitigate, or create, alternative economic futures. Acting as a more literal ‘no policy action’ reference case allows for the policy action scenarios to be tailored to Australia’s policy options and more easily be compared for analytical purposes – in particular, where the policy action scenarios have similar constraints to SSPs.
- The no policy action baseline of economic outcomes, global average temperature and emissions profile under RCP8.5 – while high with no view to likelihood attached – best supports the integration (and analysis) of regionalised damages to Australia (by state) where it is estimated that Australia would experience an above-average global temperature increase in the absence of mitigation. For example, by 2050, Queensland’s temperature could rise by 2.6 degrees (above the average temperature levels between 1986-2005), when global average temperature is set to increase by 1.9 degrees over the same period.^w
- Standard macroeconomic models and analysis used (across both the public and private sector) for forecasting, scenario analysis and specific economic policy analysis are configured to parameters that understand the current cost base of the modern economy to be founded on industrial and commercial processes that result in emissions – largely as function of energy consumption, and that energy works to improve productivity and technology. It is also a function of how, as a society, we have collectively understood what supports economic growth and improved living standards – more emissions, more growth. Where this report seeks to understand the economic consequences of this relationship for Australia and how this creates physical damages due to a changing climate, RCP8.5 provides an appropriate depiction.
- As Australia’s economic structure is highly emissions intensive and highly exposed to the physical damages of a changing climate, understanding the reference case as an outcome of the consequences of an RCP8.5 pathway demonstrates the orders of magnitude of impact well for analytical purposes.

As the fallout of the global pandemic and resulting global recession continues, with economic recovery pathways for economies in their early stages or having not yet begun – no economic future modelled over the long-term is certain. In this context, this report does not seek to predict or assume probability for an economic baseline and associated ‘business as usual’ outcome. There is no business as usual pathway.

²⁹ This analytical reference case assumes that countries do not meet their Nationally Determined Contributions (NDCs) and the global economy broadly follows the emissions pathway RCP 8.5 (based on the IPCC’s fifth assessment report, 2014). Deloitte Access Economics presents results out to 2070 in this report.

³⁰ In contemporary climate change economic impact modelling, increasingly a new set of future scenarios are now used in replacement of RCPs – the Shared Socioeconomic Pathways (SSPs) – which offer a broader view of what the range of ‘no policy action’ scenarios might look like.

New growth recovery

This report includes analysis of an economic future under an economic recovery (from covid) and net zero mitigation pathway for Australia and the world. This section steps through the three key drivers of economic change under the new growth recovery scenario.

Power system transformation and fuel switching

The decarbonisation of the electricity grid is a key enabler of fuel switching across the economy, and within industries, as firms and households substitute away from emissions-intensive fuel sources towards renewable electricity:

- Over the past decade, the demand for electricity has grown. Much of this additional demand has been successfully met by renewable sources.^x The continuing uptake of renewable energy in Australia – spurred by policy support, falling costs and increasing cost competitiveness – will help decouple the electricity grid from emissions intensive activity. Renewable energy is a mature technological solution, and while on-going developments must continue (i.e. in large-scale battery storage), it is well-positioned for widespread deployment.^y

- The shadow price formed in DAE-CLIMATE drives decarbonisation of the electricity grid through a transition to renewables across all Australian states and territories, with their share of generation rising, reaching around 90% by 2050. Fuel switching occurs across all industries in the economy; including transport and other emissions-intensive industries.
- Just as this technical switch is calibrated in DAE-CLIMATE for industries, there is an equal assumption that households also receive the signal of a net zero transition and like firms, choose to make the switch of their energy sources away from emissions-intensive sources. For instance, opting for a carbon neutral option offered on their private electricity plan.³¹
- Additionally, the power system transformation occurring in DAE-CLIMATE reflects the level of investment, and technological development required to transform Australia’s power system for an affordable, secure, reliable and decarbonised energy future.

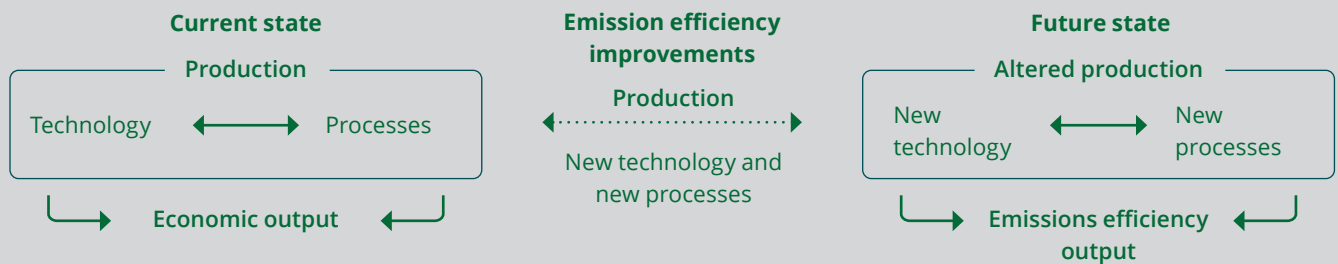
Technology advances driving emissions efficiency

Not all emissions can be removed through fuel-switching or similar types of firm and household behavioural change. Some are a function of industrial processes and emissions efficiencies (and inefficiencies) which aren’t easy to change.

Emissions efficiencies required for a net zero economy are driven by technological innovations; a result of incentives produced by a concerted effort by government to support a net zero transition (Figure A.2). Both the immediate accelerated deployment of mature technologies and the rapid development and commercialisation of emerging technologies are required to decouple emissions intensity from those harder to abate industries. Specific technologies for specific sectors and emissions are not modelled in the scenario. Rather, a general view as to how emissions efficiency could evolve overtime is modelled in line with research.

In the new growth recovery scenario, the clear and coordinated global effort toward net zero sets a signal to firms, households and the scientific community, working in conjunction with the shadow-price, to achieve emissions reductions,

Figure A.2 Technology change and emissions efficiency relationship for scenario modelling



Source: Deloitte Access Economics

31 In June 2020, a leading Australian energy provider announced that their electricity plans will offer a certified carbon neutral option.

leading to emissions efficiencies, especially in areas where current technologies are limited.

The modelling is such that in Australia, this transition is managed in an orderly and equitable way. It will require embracing a pro-growth low emissions economy and embracing opportunities to facilitate adaptation and mitigation in existing industries as well as supporting the development of nascent industries. There is no doubt that such a transition will require an active role of government but will also require buy-in and coordination across firms and community stakeholders in driving change.

In order to model a pathway towards net zero emissions, a representative emissions profile is adopted, implying a technology and policy pathway for the acceleration and deployment of mature and demonstrated technologies. This representative pathway largely reflects that described in the Decarbonisation Futures Report, published by Climate Works Australia.^z

A global fiscal sustainable recovery
Policy makers around the world have a once-in-a-lifetime opportunity to simultaneously boost economic growth, create sustainable jobs and to steer global emissions into structural decline.

As policy makers are designing economic recovery plans from covid, a combination of policy actions and targeted investment taken today can sustainably shape key industries across economies for decades to come – to take the path of economic recovery which enables a new global growth trajectory and the realisation of long-term global climate goals.

The International Energy Agency (IEA) has produced a Sustainable Recovery Plan that outlines a three-year action plan. The plan focuses on cost-effective measures that could be implemented globally, during 2021–2023. It targets six key sectors – electricity, buildings, transport, industry, fuels and low emission technologies. The plan accounts for both national and international objectives for long-term growth and sustainable jobs.^{aa}

Based on analysis conducted with the International Monetary Fund (IMF), the Sustainable Recovery Plan has three main goals: boosting economic growth, creating jobs and building more resilient and cleaner energy systems. The spending associated with this plan is around \$1 trillion (USD) for each of the next three years globally.^{ab}

Investment of this magnitude will have lasting benefits to the global economy as investment in new infrastructure, such as electricity grids and more energy-efficient buildings and industries, would improve the overall productivity of both workers and capital.^{ac} To this end, DAE-CLIMATE has implied productivity dividends stemming from investment in technological developments globally – reflective of a global sustainable recovery.

DAE-CLIMATE scenario results summary

This section presents a summary of the key results for the damages baseline and new growth recovery scenario (in comparison to the damages baseline) across the modelled period.

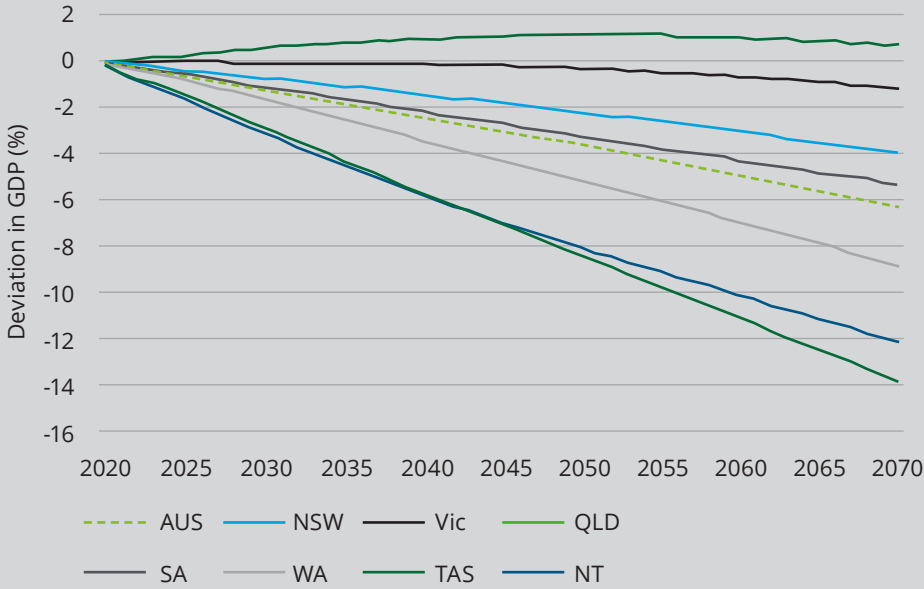
The economic cost of unmitigated climate change – the damages baseline

Table A.4 Summary of results under the damages baseline: Australia’s states and territories

	2050	2070
Temperature °C (above pre-industrial base)	2.4	3.3
Change in Australian emissions (% change from 2020)	10	49
GDP impacts (% deviation reduction in that year, in reference to an economy with no damages)		
Australia	-3.6	-6.3
New South Wales (+ Australian Capital Territory)	-2.2	-4
Victoria	-0.3	-1.2
Queensland	-8.4	-13.9
South Australia	-3.2	-5.3
Western Australia	-5.2	-8.8
Tasmania	1.2	0.7
Northern Territory	-8.1	-12.1
Employment impacts (headcount reduction in that year, rounded)		
Australia	-330,000	-880,000
New South Wales (+ Australian Capital Territory)	-65,000	-175,000
Victoria	-15,000	-55,000
Queensland	-180,000	-470,000
South Australia	-20,000	-40,000
Western Australia	-45,000	-115,000
Tasmania	1,500	500
Northern Territory	-8,000	-20,000

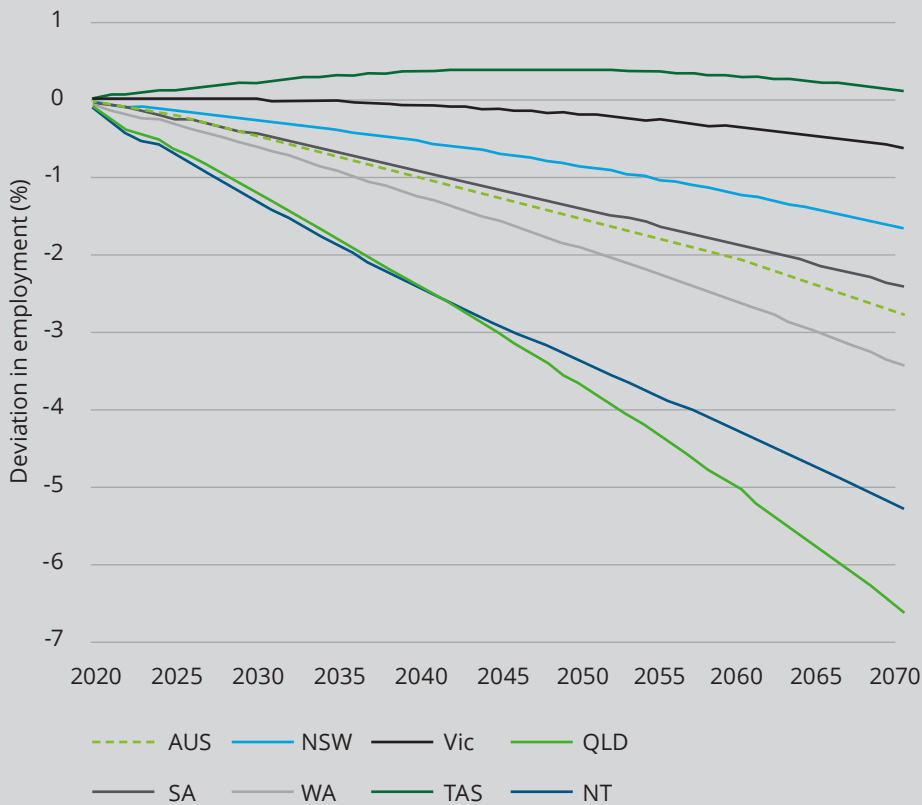
Source: Deloitte Access Economics

Chart A.1 GDP deviation to 2070 in Australia's states and territories (% deviation) under the damages baseline



Source: Deloitte Access Economics

Chart A.2 Employment deviation to 2070 in Australia's states and territories (% deviation) under the damages baseline



Source: Deloitte Access Economics

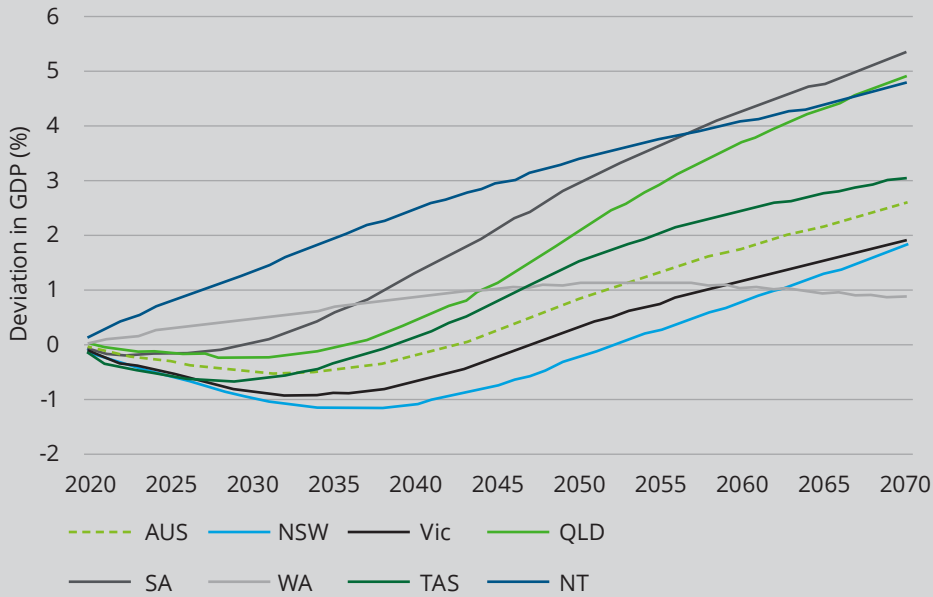
New growth recovery in Australia

Table A.5 Summary of results under the new growth recovery scenario: Australia's states and territories

	2050	2070
Temperature °C	1.6	1.6
(above pre-industrial base) emissions (% change from 2020)	-78	-87
GDP impacts (% deviation reduction in that year, in reference to an economy with no damages)		
Australia	0.8	2.6
New South Wales (+ Australian Capital Territory)	-0.2	1.8
Victoria	0.3	1.9
Queensland	2.1	4.9
South Australia	3	5.3
Western Australia	1.1	0.9
Tasmania	1.5	3.1
Northern Territory	3.4	4.8
Employment impacts (headcount reduction in that year, rounded)		
Australia	-22,000	256,000
New South Wales (+ Australian Capital Territory)	-30,000	50,000
Victoria	-21,000	30,000
Queensland	45,000	185,000
South Australia	-6,000	150
Western Australia	-5,000	-10,000
Tasmania	-7,000	-10,000
Northern Territory	2,000	5,000

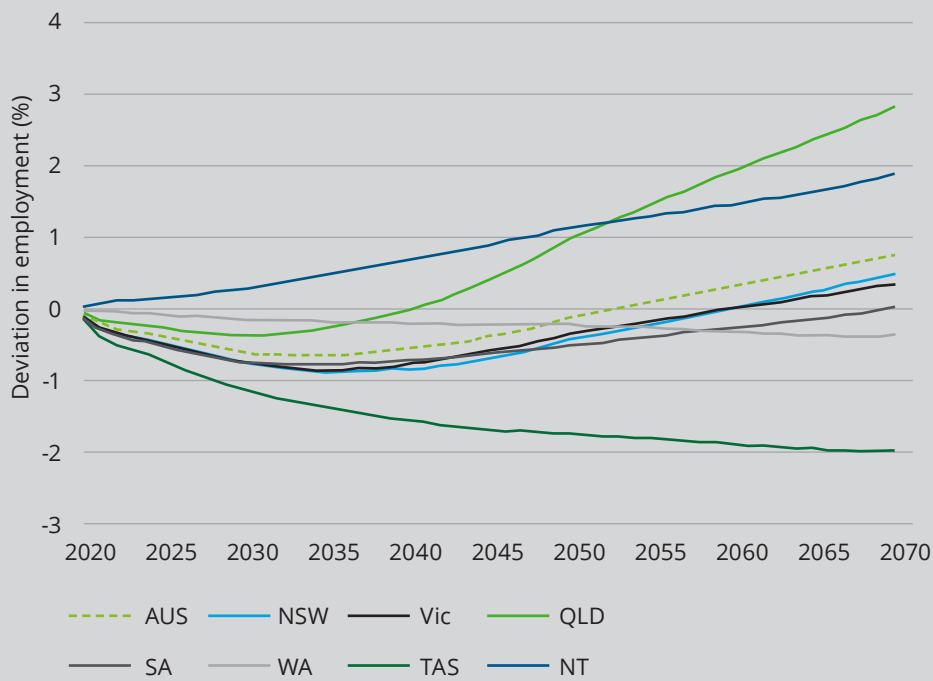
Source: Deloitte Access Economics

Chart A.3 GDP deviation to 2070 in Australia's states and territories (% deviation) under the new growth recovery scenario



Source: Deloitte Access Economics

Chart A.4 Employment deviation to 2070 in Australia's states and territories (% deviation) under the new growth recovery scenario



Source: Deloitte Access Economics

Appendix endnotes

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Pink salt lake in South Australia. Lake MacDonnell, Point Sinclair - South Australia.



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