CLIMATE COUNCIL

MISSION ZERO: HOW TODAY'S CLIMATE CHOICES WILL RESHAPE AUSTRALIA

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Cover image: A boy hiking the trail to Mount King William, Franklin-Gordon Wild Rivers National Park, Tasmania. Andrew Peacock / Getty Images.

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Key findings

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From feeling safe and secure in our own homes to being able to enjoy an off-road summer adventure, climate change is assaulting many aspects of the great Australian way of life.

- The start of summer now spells a season of anxiety, rather than fun, for many Australians who dread the more extreme heat, dangerous fire weather and intense downpours that climate change worsens.
- Driven by the burning of coal, oil and gas, climate impacts like these are disrupting cherished Australian pastimes - such as sporting events, and festivals - with increasing frequency.
- More erratic and dangerous extreme weather makes insurance less affordable for all of us, and out of reach for more of us. It's forcing some families from their homes, like we've witnessed in flood-prone Lismore and bushfire-ravaged towns of Victoria.
- Ecosystems that act as our life support system - providing water, food and essential materials - are beginning to unravel. From the Great Barrier Reef to the ancient Gondwana rainforests, many places are suffering irreparable damage.
- Climate impacts add to the burden on Australians with the fewest resources to cope: people on low incomes; regional and rural residents whose livelihoods are tied to the land; young people; and First Nations peoples, who have 65,000 years of connection to Country.

2

Humanity has already profoundly altered the Earth's carbon cycle, and incremental progress won't fix it. Too little action, taken too slowly, could trigger abrupt and major changes that rapidly overwhelm us.

- By digging up and burning fossil fuels we have profoundly altered the Earth's carbon cycle by drawing huge quantities of carbon out of long-term storage underground and pumping it into our atmosphere.
- This has tipped our Earth System out of balance and blanketed our planet in pollution that traps in heat. Our global temperature is now rising faster than anything we have seen over the Earth's entire history.
- In Australia, electricity emissions are slowly declining as we add more renewable energy to the grid, but that progress is being cancelled out by rising emissions in other parts of our economy. Once land use and forestry are discounted, national emissions have fallen a mere 0.2 percent since 2005.
- Every fraction of global warming raises the spectre of crossing a point of no return (a tipping point). The latest research warns that we may have already done so for the west Antarctic and Greenland ice sheets, leading to potentially irreversible and catastrophic changes.

3

Choices made today will substantially shape the kind of world that younger Australians inherit. The more that we can cut greenhouse gas emissions this decade, the better the prospects for us all.

- Any missed opportunity to leave coal, oil and gas in the ground increases the danger that we will face, and could condemn future Australians to hardships that are difficult to fathom.
- Stronger climate action now, and through this decade, will be measured in fewer people being forced from their land and homes, and in more First Nations communities being able to maintain their continuous connection to Country.
- Stronger climate action now, and through this decade, will be measured in more species, ecosystems – and everything that depends on them – being saved from the brink. For the Great Barrier Reef, it's the difference between having a fighting chance of survival or mostly disappearing.
- Stronger climate action now, and through this decade, will be measured in the lives and wellbeing of our children and future Australian generations who will face fewer and less intense heatwaves than would otherwise occur.
- While we cannot stop the seas from rising, we can still influence the rate at which they rise, which for many low-lying communities is the difference between survival or not.

4

Anyone proposing to use more coal, oil or gas is reckless. It's like adding more fuel to an already raging fire. It's equivalent to gambling with everything that Australians value.

- Corporations and governments that plan to dig up more coal, oil or gas are ensuring that the truly nightmarish outcomes (mass extinction and the collapse of human societies) are still among the plausible futures we face.
- We need to get as close to zero emissions as possible, and then we need to work out how to draw down massive amounts of carbon in our atmosphere. Since 1750, humans have generated around 1.5 trillion tonnes of carbon dioxide emissions; half of which was added since 1990.
- Planting trees doesn't balance out digging up and burning coal, oil or gas. Offsetting is not an equal exchange, because when we dig up fossil fuels we release carbon from long-term, stable storage and it keeps cycling between land-based ecosystems, the upper ocean and the atmosphere, where it contributes to the blanket of carbon dioxide that is heating the planet.
- We wouldn't board a plane that has a 50 percent chance of falling out of the sky. Yet, governments are setting low targets that give us the same chance of losing everything we hold dear.
- Australia is not on track to meet the inadequate national target of reducing our emissions by 43 percent below 2005 levels by 2030 and reaching net zero by 2050.

5

Today's leaders stand on the cusp of history: will they go all-in to help build a safer and more prosperous world? Or will they tip us past a point of no return, condemning everyone to a radically dangerous and unstable world?

- It is game on for climate action, not game over. The Climate Council reaffirms that Australia should strive for a 75 percent emissions cut by 2030, and net zero emissions by 2035 so we can help hold global warming at the safest levels now possible, with a decent chance of success.

- As a high-income country with sufficient public and private capital, we can build the clean energy system, transport solutions and fully-electric homes we need. This will help tackle long-standing inequalities and support Australians doing it tough, at the same time as reducing harmful emissions.

- We will need to replace our fossil fuel exports by developing the clean energy, new industries and technologies that are increasingly in demand. This means Australia can help cut emissions around the world, while getting paid for it.

- When it comes to individual choices and behaviours, many of the climate solutions are already at our fingertips, including all-electric homes that use less energy, and cleaner transport options. They just need adequate investment, so more people can access them.

- As Pacific leaders have put it: we're all in the same canoe when it comes to combating climate change, and if we paddle together there's nothing we can't do.

Dedicated to Professor Will Steffen (1947-2023), pioneering Earth System scientist, gifted climate communicator, and kind man.

Will wrote the 2021 report *Aim High, Go Fast*, on which this report builds. The groundbreaking scientific contributions he made will continue to shape our understanding of the climate crisis for many years to come.

1. Introduction

In a world pummelled by the consequences of the climate crisis, our simple pleasures, our livelihoods, and our overall safety and security are now under siege. This reality is confronting, and forces us to reckon with what we have already lost and muster up every bit of motivation to come together to safeguard what remains.

Over the past two years, since the publication of our report *Aim High, Go Fast*, and nearly a decade on from the moment countries from around the world decided under the *Paris Agreement* on how to respond to climate change, the impacts have continued to escalate. Already at 1.2°C of global warming, the world is grappling with stark realities as the toll on people and nature gets bigger and bigger: families uprooted by floods and fires, iconic ecosystems like the Great Barrier Reef irrevocably harmed, entire species driven to extinction. And, too many lives lost.

At the same time, having squandered opportunities to reduce emissions, the window for avoiding catastrophe is now even narrower. No family, community or country will remain untouched by the far-reaching impacts of climate change. Yet, climate change does not strike equally. It knows no borders, and disproportionately affects those who have often contributed least to the problem or who have limited resources to cope.

The monumental significance of this crisis is hard to overstate. We are getting dangerously close to crossing points of no return, triggering cataclysmic and irreversible changes like the collapse of major ice sheets or loss of the Amazon rainforest. The latest science suggests changes are unfolding faster than expected, including in Australia.

As climate communicators we often hesitate to lay bare the full extent of the problem fearing it may dishearten. Instead we emphasise the real, tangible opportunities that action on climate can bring, from burgeoning clean industries to better health and lives for our future generations.

The reality is simple: there's no safe level of global warming and everything we do now matters. In this report, we explore the latest global science and data to break down the projections and what this means for Australia. We explain the science and debunk dangerous false solutions getting in the way of genuine climate action.

As we teeter at the edge of crossing perilous tipping points in our climate system, so too are we at inflection points when it comes to the opportunities for transformative action. This window might be narrowing, but a brighter and safer future is still possible if we throw everything we've got at the climate crisis this decade.

For Australia, we must get our emissions on a steep downward trajectory with an actionable plan to reduce emissions by 75 percent below 2005 levels by 2030 and reach net zero by 2035. This is doable. It requires an all-in effort that builds upon our modest progress to date. Fortunately we have the technology. The economics are favourable. Plus, the benefits to our health, our economy and our communities - our way of life - are undeniable.

Today we must ask our leaders - do you want to be remembered for inching ahead with incremental changes that fell catastrophically short of what we knew was necessary? Or for striving to get it right by rising to the challenge and seizing all the opportunities now before us?

Figure 1: Australia is the sunniest continent, with enormous potential for solar power. We also have some of the best potential for wind power. Nonetheless, we remain highly dependent on fossil fuels, with only around a third of our electricity generated from renewable sources, and only 15% from the sun (Clean Energy Council 2023). Despite our vast untapped renewable energy potential, and in the midst of an accelerating climate crisis, the Australian Government has continued to approve new fossil fuel projects. We can and must do better.

2. The things we have lost and those we must fight to save

What makes us happy? Perhaps the taste of our favourite food. Or lazy summer afternoons by the shore. It could be coming together to watch the footy with mates, or watching our children take their precious first steps. Maybe it's heading off on a great Australian adventure to be awed by our extraordinary landscapes, history and wildlife. For many, it's simply feeling safe and secure in our home with our family.

Whatever it is, you and I can no longer take these things for granted. Everything we need in life, and everything that brings us joy is threatened by climate change. Everything that keeps us safe, nourished and healthy is being undermined by the climate crisis; driven by the burning of fossil fuels.

Decades of denial and delay have cost us all dearly. For many, the great Australian summer is now something to be feared. Relaxed vibes replaced by anxieties over worsening fire danger. From weekend sporting matches to music festivals, the things that have shaped Australian cultural and social life for generations, are now at risk (Climate Council 2021c, 2023c). Our critical ecosystems, from the Great Barrier Reef to the ancient Gondwana Rainforests, have suffered irreparable damage (Climate Council 2019). Entire species – the products of millions of years of evolution – have been lost. Families have been torn from their land and homes by floods and fires. This is what climate change feels like.

No family, community or individual is immune from these impacts. No amount of wealth or power can fully shield us from escalating extreme weather disasters and their impact on our critical infrastructure and supply chains. Nothing can compensate for the knowledge that children growing up today may experience our environment as a source of risk and menace, not of wonder.

But neither are we all affected equally. The impacts of climate change are being felt first and hardest by those who contributed the least to the problem, and have the fewest resources to cope: Australians on lower incomes, those in poorer health and more vulnerable to extreme heat. Those who live in rural Australia, and whose livelihoods are tied to the land – a land that is changing before their eyes. Younger Australians, with more of their life ahead of them and who may never enjoy the relative safety and security with which older generations were blessed. For First Nations peoples, the impacts go beyond loss of physical security, and cut to the very core of being and belonging; affecting 65,000 years of culture and connection to Country.

At its heart, climate action is about protecting the people, the places, and the things that we not only love but ultimately depend upon for our health and well-being.

The true magnitude of what's at stake is hard to overstate. This is the only planet known to support life. We are witnessing the unravelling of the conditions under which our complex human societies were built, and without which they may collapse.

Such revelations are confronting. So much so, that people often skip over the predicament we now find ourselves in and choose instead to focus on the benefits of stronger action: new jobs in renewable energy, better health, communities taking control of their future, and prosperous new clean industries. While these opportunities are there for the taking, we must reckon with the situation we're in, and what's truly at stake. So we can muster the motivation required for the task ahead, and fight like hell to save what we hold dear.

Every smart action towards reducing greenhouse gas emissions will be measured in a safer, healthier and happier future. Every squandered opportunity to reduce emissions is increasing the dangers and hardships for future Australians and communities worldwide.

Climate action is about building a better, brighter, future for all. But it is also a matter of our very survival.

Every step taken to cut the use of coal, oil and gas is measured in safer, healthier and happier lives for all Australians.

2.1 Collapsing ecosystems

From the world's oldest forests to its largest coral reef system, Australia is home to some of the most remarkable ecosystems on the planet. These national treasures harbour an extraordinary array of plant and animal species; a majority of which are endemic – meaning they are found nowhere else on Earth.

Iconic species like the koala and river red gum are core to Australian identity and culture. People flock from around the world to visit our many World Heritage Sites such as Kakadu, the Wet Tropics of Queensland, the Gondwana Rainforests, and the Great Barrier Reef.

At today's global average temperature rise of 1.2°C, many of these sites have already suffered tremendous damage. A recent CSIRO-led study has affirmed that World Heritage Sites across Australia and around the world are "facing unprecedented challenges from climate change" (Lin et al. 2023).

More than half of the Gondwana Rainforests in New South Wales and Queensland were affected by the catastrophic Black Summer fires of 2019-20 (Climate Council 2020). The Gondwana Rainforests are a link to our deep past – a living remnant from the ancient Gondwana supercontinent, which began to split apart around 180 million years ago to form Australia and other continents we live on today. The Gondwana Rainforests include the largest area of subtropical rainforest on the planet and are home to many endemic plant and animal species, some of which are considered 'living fossils' due to their ancient lineage. As moist rainforests, these rich ecosystems – which developed over many millions of years – were previously considered too wet to burn. It is unlikely they will ever return to their previous ecological state (Climate Council 2020).

Further north, the Wet Tropics of Queensland support the highest level of biodiversity anywhere in Australia. Despite covering only 0.12 percent of the Australian landmass, these forests support more than a third of Australian mammal species and half of all Australian bird species (Wet Tropics Management Authority 2019). They have been recognised as one of the most irreplaceable protected areas in the world (Bertzky et al. 2013). Like the Gondwana Rainforests to the south, many of the species here are living relics of our ancient past and found nowhere else on Earth. Climate impacts, including higher temperatures and shifting rainfall, have emerged as the number one threat to this biodiversity hotspot (Wet Tropics

Sadly, the Great Barrier Reef is now a poster child for the climate crisis with repeated bleaching events damaging its coral, and vibrancy. Losing reefs entirely would have knock-on effects felt across our food system that are hard to fathom.

Management Authority 2019). Twenty years ago, scientists warned that unless more was done to reduce greenhouse gas emissions, climate change could drive more than half the endemic vertebrates to extinction (Williams et al. 2003). Alarmingly, many of these species, including ringtail possums and many birds, have been declining in population size and distribution area faster than predicted (Hoffmann et al. 2018).

The Great Barrier Reef, our most famous natural wonder, is a poster child for the climate crisis. Too much heat stress causes corals to expel the symbiotic algae that provide them with essential nutrients and give them their vibrant colours. Prolonged bleaching can cause the corals to die. The Reef has been affected by marine heatwaves that resulted in four mass bleaching events in the past decade – in 2016, 2017, 2020 and 2022. The 2016 event, the worst on record, affected more than 90 percent of the Reef (Hughes at al. 2018) with nearly 30 percent of corals on the Reef dying (Climate Council 2018). This event would not have occurred in the absence of climate change (King et al. 2016). Taken together, the 2016 and 2017 mass bleaching events saw the loss of half of all shallow water hard coral cover across the Reef (IPCC 2019). Under a 'high emissions scenario', the Reef could face such bleaching conditions every year after 2044 (Heron et al. 2018, IPCC 2022c). This would effectively destroy the Reef, and most shallow water tropical reefs worldwide.

While much damage has already been done, there is so much that we still can and must fight to save. Indeed, stronger climate action now and through this decade will be measured in more species, ecosystems – and everything that depends on them – saved from the brink. When it comes to the Great Barrier Reef, stronger action this decade could be the difference between giving the Reef a fighting chance of survival or watching it mostly disappear (Climate Council 2022a).

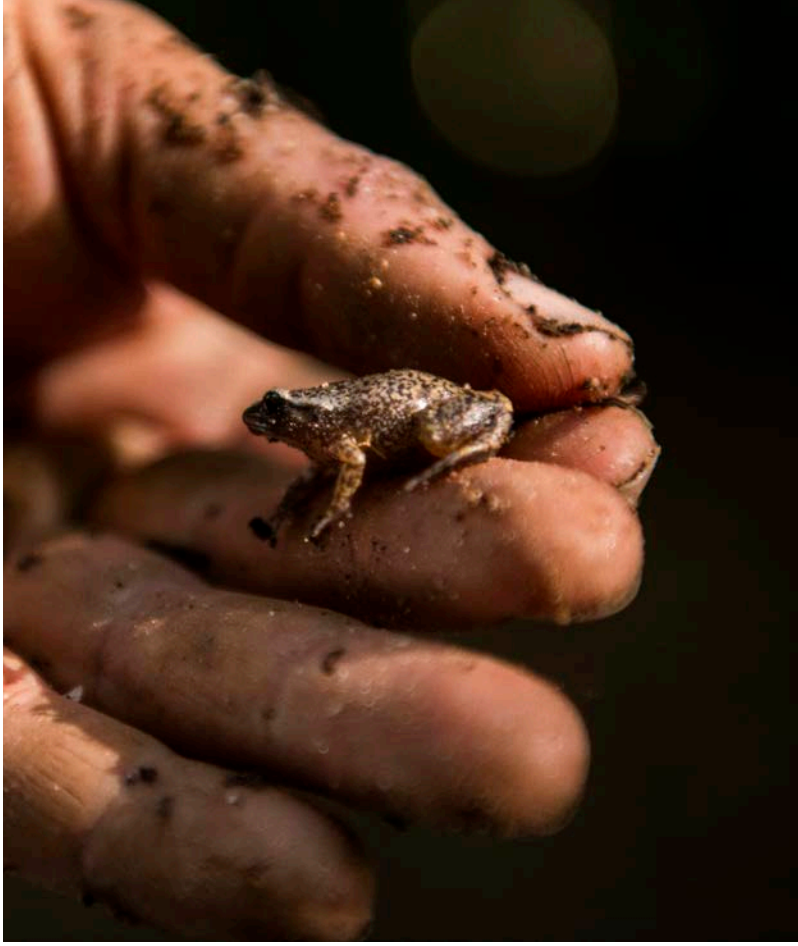


Figure 2: A Rain Whistling Frog, spotted in Far North Queensland's Atherton Tablelands. The majority of our mammals, plants, reptiles and amphibians are endemic, meaning they are found nowhere else in the world.

Damage to these critical ecosystems will be measured in the loss of tourism dollars, and livelihoods in Queensland's coastal communities. We must also recognise that Aboriginal and Torres Strait Islander peoples, who flourished sustainably on this continent for thousands of generations prior to colonisation, have deep connections to these landscapes, seascapes, and species, and are profoundly affected by such losses.

Ultimately, the unravelling of these ecosystems represents the unravelling of our very life support system. The loss of tropical coral reefs, for example, would have knock-on effects throughout the marine food system that are hard to fathom. We are all fundamentally dependent on diverse and productive ecosystems for our food and other basic needs. Put simply, every tonne of carbon left in the ground, every action to accelerate cutting emissions, is protecting the species and ecosystems that we love and depend upon.

2.2 A loss of innocence

The Australian summer has a special place in our hearts. A time of laughter, of unwinding from the year's stresses, of bare feet on warm sand, of cool beers and barbeques, of long afternoons at the cricket, and a cacophony of nature's sounds.

These summers are changing, with deadlier heatwaves, worsening fire conditions, prolonged droughts, extreme downpours and other climate impacts harming the Australian way of life. For too many of us, summer's approach is now met with rising anxiety (The Guardian 2023c). Some have begun to lament the loss of the great Australian summer (ABC 2020). Fire expert Professor David Bowman has suggested it is time to rearrange the peak holiday period to a safer time of year, rather than expose tens of thousands of holidaying Australians to the peak of bushfire danger (Bowman 2020).

Climate change means more extreme heat, more dangerous fire weather, and more intense downpours (BoM and CSIRO 2022). This threatens some of our most cherished Australian pastimes – our summer sports and festivals. In recent years, extreme heat has regularly interrupted play at the Australian Open tennis tournament, cricket matches have been cancelled due to bushfire smoke, while rain and flooding has forced the cancellation of music festivals (Climate Council 2021c, 2023c).

Figure 3: Junee, New South Wales, 5 January 2020. Nearly 80 percent of Australians were affected either directly or indirectly by the 2019-20 Black Summer fires – a disaster fuelled by climate change (Biddle et al. 2020).

Extreme heat is one of the most direct and measurable climate impacts, and one of the costliest when it comes to our health and wellbeing. Some of the extreme heatwaves observed around the world in recent times were found to be statistically impossible without climate change (Zachariah et al. 2023). More Australians have died as a result of extreme heat than any other natural hazard (BoM and CSIRO 2022).

Extreme heat is also an aspect of climate change where there is great potential to turn things around, and limit future harms. Rapid and sustained cuts in greenhouse gas emissions would lead, beyond 2040, to fewer deadly heatwaves compared to a scenario in which the world fails to take adequate action. By the end of the century, well within the lifespan of many young Australians, strong action through the 2020s will have reduced many other impacts that would otherwise occur, including the frequency of extreme downpours and flooding (IPCC 2021a).

The future of the great Australian summer, like so many of the things we cherish, depends on the scale and speed of action that Australia and the world chooses to take throughout the 2020s to phase out the use of coal, oil and gas.

We can turn things around, and limit future harms, with strong climate action. For example, young Australians would face fewer lethal heatwaves during their lifetime.

2.3 The toll on our mental wellbeing

Every Australian is affected by climate change. Whether we've lost our home or livelihood to fire or flood, been forced to pay higher prices for our food or insurance, stayed indoors to avoid bushfire smoke blanketing our cities, or witnessed our landscapes and wildlife being devastated by bushfires.

Research by the Climate Council, supported by Beyond Blue, has begun painting a picture of how climate change affects our mental health, and why climate action is fundamental to protecting the mental wellbeing of Australians (Climate Council 2023a).

A national poll of more than 2,000 people revealed that the majority (80 percent) of Australians had experienced some form of extreme weather disaster since 2019. More than half (51 percent) of those who had experienced an extreme weather disaster since 2019 felt their mental health had been somewhat affected. One in five (21 percent) said that the disaster they went through had a "major or moderate impact" on their mental health (Climate Council 2023a).

Behind these statistics are countless stories of mental anguish, shattered dreams, anger over government inaction, and a sense of helplessness and despair. Alongside the national poll, 500 Australians bravely volunteered accounts of their personal experiences of extreme weather disasters.

> *"When there is a storm now and very heavy rain I feel anxious – panicky and stressed, hypervigilant, and also a sense of foreboding dread."*
>
> - Brisbane resident, Queensland
>
> *"I literally dislocated my jaw with stress last year (clenching). With another dramatic summer upcoming, my body is in constant physical pain again."*
>
> - Blackheath resident, New South Wales

Australians living outside of cities are more likely to have been affected by flooding or bushfires, but less likely to have access to the mental health support they need.

Figure 4: A majority (80 percent) of Australians report having experienced some form of extreme weather disaster since 2019, more than half (51 percent) of whom felt their mental health had been somewhat affected (Climate Council 2023a).

From the cities to the most remote parts of the continent, Australians everywhere are being harmed by extreme weather disasters. But while no part of the country is spared, some areas and some groups of people are clearly being harmed more than others and suffering a greater toll on their mental health.

Our research has shown that people in regional, rural and remote areas are far more likely to have been affected by flooding at least since once 2019 (61 percent) than people living in urban areas (38 percent), and significantly more likely to have been affected by bushfires (49 percent) than people in urban areas (36 percent). People living outside of major cities are also less likely to be able to access mental health support (Climate Council 2023a).

Our research has also highlighted the mental health toll of climate change on young people, with nearly a third of people aged 18-34 "very worried" about climate change (compared to just over a fifth for older Australians). These findings are consistent with those of the Intergovernmental Panel on Climate Change (IPCC), which concluded that children and adolescents – especially girls – are at particularly high risk (IPCC 2022b).

Many young Australians consider the steps that governments the world over are taking to be grossly inadequate. In 2021, a groundbreaking survey of 10,000 young people across ten countries revealed that high levels of climate anxiety in young people are linked to perceived inaction by their government and associated feelings of betrayal (Hickman et al. 2021). In this study, more than six in ten young Australians felt this way. The consequences of this lack of trust in leaders will resonate through our democratic system in the years to come.

Working together to tackle the climate crisis offers a powerful antidote to such anxiety and despair (Climate Council 2023a). A number of respondents to our community survey talked about how working with their community on climate solutions was central to their recovery. It's no surprise that greater hope for our future means better mental health.

The conclusion is inescapable: stronger action on climate change – both to reduce emissions and to support communities which are coping with the impacts – is fundamental to protecting the mental health and wellbeing of Australians, and communities worldwide.

BOX 1: FIVE WAYS THAT STRONGER CLIMATE ACTION THIS DECADE WILL DELIVER *IMMEDIATE* BENEFITS FOR AUSTRALIANSS

Better health thanks to cleaner air

Burning coal, oil and gas is not only damaging our climate. Fossil fuel combustion also pollutes our air with particulates, causing a range of health problems. One study has estimated that air pollution from fossil fuel combustion is responsible for around 5,700 deaths in Australia each year, or four percent of all deaths each year (Vohra et al. 2021). Moving beyond fossil fuels will clean up the air we breathe, resulting in fewer deaths. Better air quality also means healthier Australians.

Fewer deadly heatwaves

Stronger action today will start to limit the rise in average global temperature within around 20 years (IPCC 2021a). That means that from 2040 – well within the lifetime of most Australians alive today – we would experience fewer lethal heatwaves than would otherwise occur. Heatwaves are considered the deadliest type of disaster; putting severe stress on the human body and leading to increased deaths as well as serious illnesses including heatstroke, and heart, kidney and lung disease.

Better mental health

Working together to tackle the climate crisis is important for our mental health. So, too, is having confidence that our governments are taking the crisis seriously and working to protect our future (Climate Council 2023a). Stronger action on climate change today is fundamental to improving the mental health of Australians, and especially young Australians.

Affordable, reliable energy

CSIRO has made it clear that the lowest-cost future of our electricity system is one that's powered by renewable energy, like solar and wind, backed by storage (CSIRO 2023). The faster we shift from expensive coal and gas towards renewable electricity and improve energy efficiency, the sooner households and businesses will be able to benefit from permanently lower power bills.

More and better jobs

Whether in renewable energy, land restoration, new clean industries like green steel, or the countless other industries that will propel Australia out of the fossil fuel era off the back of cheap and plentiful renewable energy, stronger climate action will create more jobs and better economic opportunities for Australians today, and for many generations to come.

2.4 Forced from home

Scientists have warned for decades that communities and even entire nations could be displaced from their land and homes by rising seas and extreme weather disasters. Nonetheless, for many, this prospect felt remote. Today, as we live with the consequences of past climate inaction, many communities have been uprooted or face the growing risk of displacement.

Scientists have long warned of people at risk of being forced from their homes due to climate change. Today, many Australians aren't able to return home after a fire or flood, and many Aboriginal and Torres Strait Islander communities are under threat from worsening extreme weather.

We have long known of the acute threats facing residents of low-lying islands and river deltas. In Australia, Torres Strait Islanders are on the frontline of the climate crisis and fighting hard to protect their homes and cultures (Our Islands Our Home 2023). However, it is not only coastal communities that are in harm's way. In central Australia, First Nations communities around Alice Springs fear being forced from their Country by extreme heat (The Guardian 2019) – just one example of the acute impact climate change has on Aboriginal and Torres Strait Islander peoples. Elsewhere, people living along the banks of both inland and coastal rivers, such as Lismore in New South Wales, face growing risks from extreme downpours and flooding. Research by the Climate Council suggests that one in 25 Australian properties could be faced with unaffordable insurance by 2030 (Climate Council 2021d). In the worst cases, parts of Australia may simply become uninhabitable. Among the 500 Australians who shared their stories with the Climate Council, one in seven said they had been unable to return to their home following an extreme weather disaster (Climate Council 2023a).

Forced displacement epitomises the brutal reality and injustice of climate change. Few things are more precious than the safety and dignity of having a home, or the bond we each have to our community. For First Nations peoples, the impacts of displacement go far beyond the loss of physical security; profoundly affecting their deep ancestral connections, and undermining their very culture and identity.

Figure 5: Steven Kamfu, 58, in the tin house he calls home in Drive-in Camp, near Tennant Creek. The tin sheds in Drive-in Camp were disconnected from water, electricity and rubbish collection services as a result of a series of policy and legal interventions into the Northern Territory beginning in 2007. Yet because of housing shortages, many tin sheds like this — leaky in the rain, cold in the winter and scorching hot in the summer — are still inhabited.

Regional and remote communities are expected to be particularly exposed to higher temperatures (Australian Government 2023). Poor housing like this can leave communities especially vulnerable, and disproportionately impacted.

SEA LEVEL RISE

As with all the other climate realities explored in this chapter, the choices we make now to rapidly cut emissions by moving beyond fossil fuels like coal, oil and gas will significantly improve the prospects of communities in Australia and worldwide. Let us specifically consider the challenge of sea level rise.

Unfortunately, we cannot halt sea level rise even if we were to reach zero emissions tomorrow. Seas will continue to rise for centuries or millennia due to the carbon pollution that's already blanketing our planet. This is because the processes that drive sea level rise, including the thermal expansion of the ocean (that is, the increase in volume as the ocean warms), the melting of ice sheets, and the circulation of heat in the deep ocean have a considerable time lag. While the atmosphere itself responds relatively fast to reductions in greenhouse gas emissions, so we can quickly start to reduce temperatures and limit the impacts that would otherwise occur, the ocean takes much longer to respond. As the ocean absorbs more heat, it will take centuries for that heat to circulate through its depths and for a new equilibrium (that is, a new stable state) to be reached. The same is true of ice: when we rapidly raise the temperature, as we are doing today, ice begins to melt. But the melting process is relatively slow, lagging behind the change in air temperature. Therefore, if we manage to arrest the global average temperature rise later this century, the melting will not stop immediately. Instead, it will continue until it is in equilibrium with that new temperature we have reached.

However, and here is the rub: while we cannot stop the seas from rising, we can still influence the *rate* of future sea level rise. This matters, as for many communities worldwide, stronger global action this decade to drive down emissions may well be the difference between a rate of sea level rise they can survive – albeit with great difficulty – and one which completely overwhelms them.

Under the IPCC's very low greenhouse gas emissions scenario – where we roughly halve global emissions this decade and reach net zero around 2050 – sea levels are projected to rise by 0.28-0.55 metres over this century. In contrast, under the very high greenhouse gas emissions scenario – where

When it comes to sea level rise, our actions today will be measured in fewer people being forced from their Country, communities and homes, and in more people retaining their safety, security and dignity.

we remain highly dependent on fossil fuels – the projected sea level rise over this century roughly doubles (to 0.63-1.01 metres). The IPCC further warns that under the very high greenhouse gas scenario, much larger rises – approaching 2 metres by 2100 and 5 metres by 2150 – cannot be ruled out (IPCC 2021a). Notably, these projections are limited by current understanding of how the world's ice sheets will respond to temperature rise so we can not say with certainty what will happen.

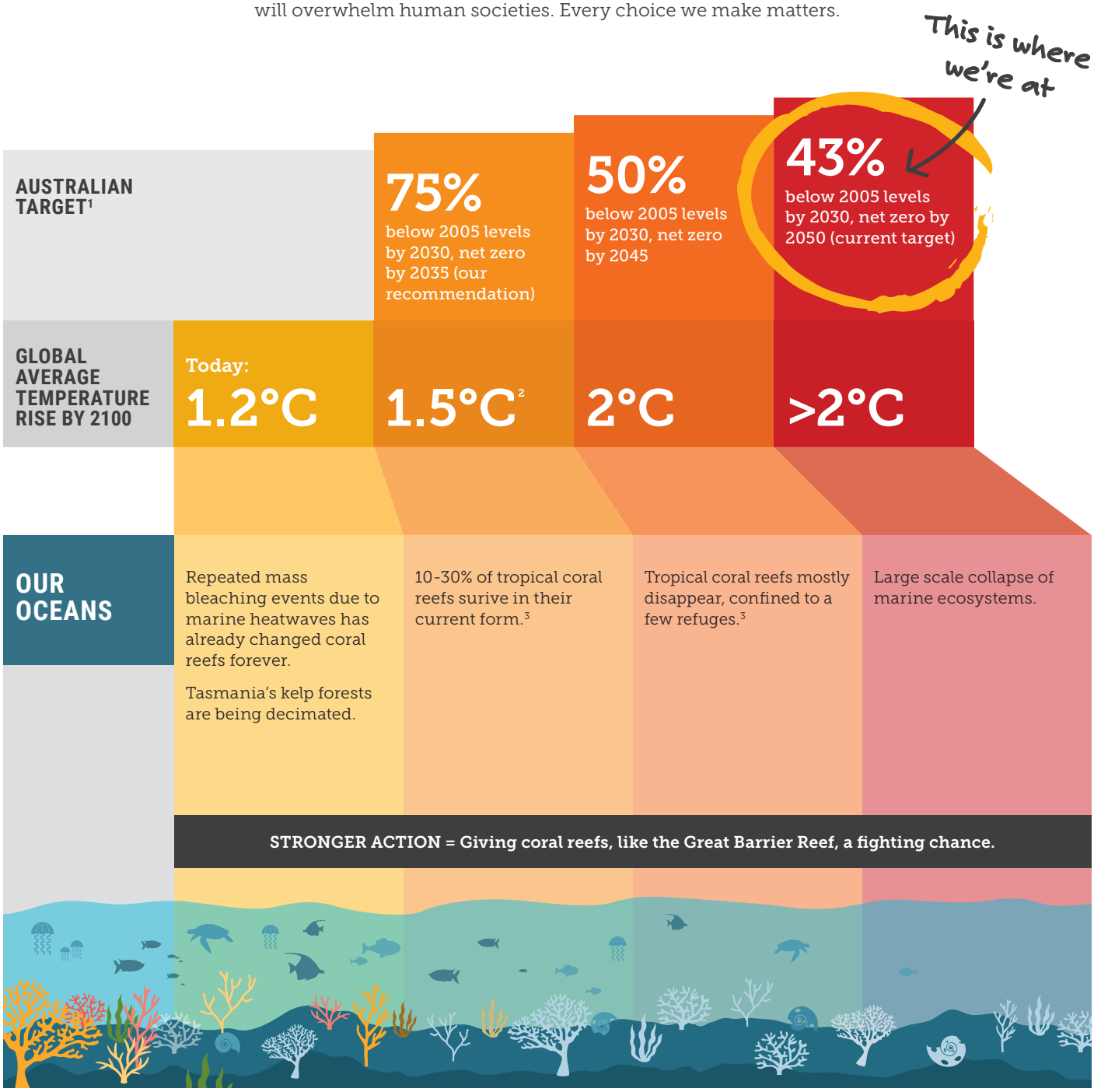
With further sea level rise locked in, many communities in Australia, the Pacific and beyond face a difficult and uncertain future. Beyond doing everything possible to drive down emissions and slow the rate of sea level rise, we must also do far more to support communities exposed to sea level rise to adapt to the changes that we know are coming. For some, this means improving coastal defences and other measures that enable them to remain where they are. For those who have no choice but to move, it is vital they receive the necessary support and are empowered to shape their own future, recognising that relocation is both logistically challenging and may have devastating impacts on a community's culture, identity and connection to its place.

Ultimately, when it comes to the pain and injustice of forced displacement, our actions today will be measured in fewer people being forced from their land and homes, in more First Nations communities being able to maintain connection to Country, and in more people having the security and dignity of a safe home.

OUR FUTURE, OUR CHOICE

The type of world that we all live in will be defined by how quickly we can phase out the use of coal, oil and gas.

The faster that we cut greenhouse gas emissions this decade - by phasing out fossil fuels - the better our future. Stronger action will limit harms; protecting more people and preserving the ecosystems that we depend on for our survival. Failing to do enough, quickly enough, could trigger changes in the Earth system that will overwhelm human societies. Every choice we make matters.



SEA LEVELS

Today, sea levels have already risen by 0.2m; eroding our coasts and putting many low-lying communities in our region at risk of displacement.

For many locations in Australia, historical 1-in-100-year coastal flooding events occur more frequently, and become annual by 2100.[4]

The atoll nations of Tuvalu, Kiribati and the Marshall Islands lose more and more land and freshwater resources to rising seas and storm surges.

Seas rise a further 0.44-0.76m by 2100.[3]

Around 200 million people could be at risk of displacement.[5]

Seas continue to rise 2-6m over the next 2,000 years.[3]

Coastal inundation and storm surges increasingly impact our coastal communities, infrastructure, and businesses; costing hundreds of billions of dollars.[4]

Seas rise a further 0.63-1.01m by 2100, with a possibility of larger rises of up to 2m.[3]

Up to 250,000 Australian properties are at risk of coastal flooding.[4]

Half a billion people could be at risk of displacement globally.[5]

Even greater and faster rises over the next 2,000 years.[3]

STRONGER ACTION = Limiting sea level rise so more people and their homes remain safe.

FOOD

Across Australia and the world, shifting rainfall patterns and extreme temperatures are making life tougher for farmers. Farming is now more unpredictable and risky.

Climate change has already slashed the profitability of Australian broad-acre farms by an average of 22% since 2000.[4]

Globally, yields of staple crops including wheat, rice, maize and soybean suffer. In Queensland, changes in growing seasons attributed to global warming decrease maize production.[4]

Declining rainfall and more frequent droughts in south-eastern and south-western Australia intensify. Declining river flows reduce water availability.[4]

Globally, agricultural yields fall rapidly.[7]

Changes in growing seasons result in wheat and soy yield declines across the Australian east coast when global warming exceeds 2°C.[4]

Significant reductions also expected in oil seeds (-35%), wheat (-18%), fruits and vegetables (-14%), plant fibres (-7%) and other fibres (-11%) in Australia above 3°C.[4]

Tipping points could trigger major shifts in rainfall patterns resulting in the collapse of our food systems.

STRONGER ACTION = Better food security for Australians, and fewer people going hungry worldwide.

DROUGHTS, FIRES & FLOODS

Cool season rainfall has already declined across the southern half of Australia since the 1970s. Meanwhile, heavy rainfall events are becoming more intense and increasing our flood risk.[8]

Australia has already seen an increase in extreme fire weather, with a longer fire season, across large parts of the country since the 1950s.[8]

Over large areas of the world, extreme agricultural droughts are projected to be at least twice as likely at 1.5°C global warming.[6]

Globally, an extra 62 million people will be exposed to drought each year if we reach 2°C, compared to 1.5°C.

Significant increase in the frequency and severity of wildfires compared to 1.5°C.[9]

Globally, drought, fire and flood risks, and associated damages, are projected to increase with every fraction of a degree of warming.[6]

In Australia, the number of extreme fire days will double at 3°C or more of global warming.[4]

STRONGER ACTION = Fewer Australians at risk of water scarcity, deadly floods and fires.

EXTREME HEAT

In all regions of the globe, extreme heat events have resulted in deaths.[6]

Globally, around 350 million people will regularly face conditions in which it is too hot to work safely.[10]

In Queensland, heatwaves occur three times a year, each lasting 7.5 days on average.[4]

Many communities in eastern and south-western Australian regions will need to consider alternative water supply options due to declining rainfall.[4]

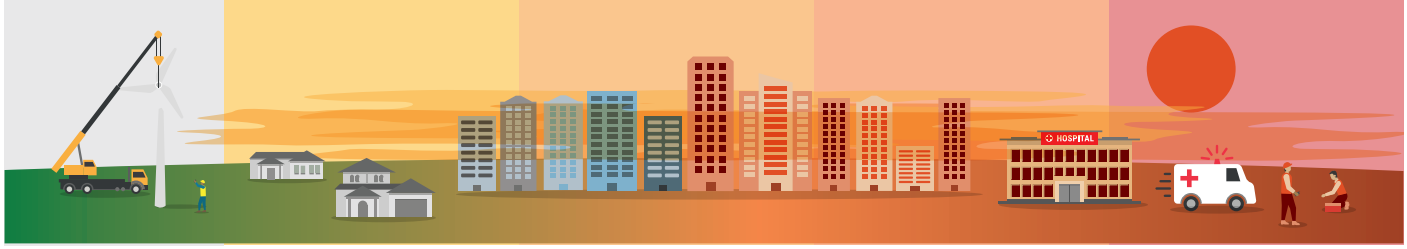
Tropical diseases spread to more temperate areas across Australia, including major population centres.[4]

In Queensland, heatwaves occur at least four times a year now lasting 10 days on average.[4]

At 3°C of warming, days above 50°C are very likely to be a regular occurrence in Sydney and Melbourne.[4]

At 3°C of warming, in Queensland heatwaves occur as often as seven times a year and last on average 16 days.[4]

STRONGER ACTION = More Australians can safely work and play, and fewer people die or fall ill due to lethal heat.



[1] Based on global carbon budgets from IPCC (2021) and allocating Australia a 0.97 percent share of the global budget. [2] There is a very low likelihood of limiting warming to 1.5°C by 2100 without a temporary overshoot. Consistent with IPCC (2021a), here we assume that the global average temperature peaks above 1.5°C and is returned to 1.5°C or below by 2100. This means quickly getting beyond net zero and removing large amounts of greenhouse gases from the atmosphere. [3] Source: IPCC (2021a). [4] Source: Australian Academy of Sciences (2021). [5] Source: Kulp and Strauss (2023). [6] Source: IPCC (2022a). [7] Source: UNEP (2021). [8] Source: BoM and CSIRO (2022). [9] Source: Son et al. (2021). [10] Andrews et al. (2018).

3. Carbon 101

3.1 The carbon cycle, fossil fuels, and climate change

To properly understand the situation we now find ourselves in, and the scope of action required, we need to go back to the building blocks of life.

Carbon plays an essential role in supporting life on Earth and maintaining a liveable climate. Carbon exists everywhere on Earth: in our atmosphere and ocean, in living matter, and in the ground beneath our feet. It is constantly circulating between these different realms. We call this the carbon cycle.

The carbon cycle is one of the basic processes that sustain life. Along with other natural processes, it has created the conditions that have enabled human societies to thrive and upon which we depend for our survival.

Figure 6: An open cut coal mine in the Hunter Valley. Global fossil fuel subsidies surged to a record $US7 trillion dollars in 2022 (IMF 2023). Existing policies and actions enable more fossil fuels to be burnt, putting the world on track for a catastrophic 2.7°C of warming by the end of this century (Climate Action Tracker 2022).

In addition to providing energy to living things, the carbon cycle plays a major role in regulating our climate. The amount of carbon dioxide (CO_2) and other greenhouse gases in the atmosphere determines the amount of heat from the sun that is trapped rather than being reflected back into space. Raise the concentration of greenhouse gases and we are effectively adding another blanket over our planet that traps more heat and energy in our climate system, amplifying weather variability. This creates havoc for human societies, as we face new extremes that none of our infrastructure, agricultural systems, homes and so on were built for.

So far, so simple. But to fully comprehend today's climate crisis we need to dig a little deeper into the carbon cycle; literally and proverbially.

The carbon cycle is best understood in two parts: the 'fast' or 'active' carbon cycle, and the 'slow' carbon cycle. Understanding this distinction is fundamental to making good decisions about climate action. Yet it is almost always overlooked.

THE FAST CARBON CYCLE

The fast carbon cycle refers to the rapid exchange of carbon between the atmosphere, living matter, and the upper layer of the ocean. CO_2 in the atmosphere is converted by plants into organic matter through photosynthesis. When animals eat the plants to obtain energy, the organic compounds are broken down again through respiration, with some of the carbon going back into the atmosphere as CO_2. When animals and plants die and decompose, some of the carbon stays in the soil, as organic matter, while some goes back into the atmosphere as CO_2. Meanwhile, carbon is constantly being exchanged between the atmosphere and the upper layer of the ocean: CO_2 is dissolved, converted into organic matter by tiny marine plants we call phytoplankton, eaten and converted back into CO_2 by marine animals, moved around by ocean currents and circulation, and diffused back into the atmosphere.

THE SLOW CARBON CYCLE

Alongside the fast carbon cycle, we have a set of much slower processes through which carbon moves in and out of long-term storage. This includes a series of geological processes through which carbon moves in and out of the Earth's crust and upper mantle. It also includes the transport of carbon from the upper layers of the ocean to the deep ocean. These processes, through which carbon is taken in and out of the fast carbon cycle, are known as the slow carbon cycle.

The vast majority of the Earth's carbon exists not within the atmosphere, ocean or living matter but in rocks and sediments. Carbon moves from the Earth's crust into the fast carbon cycle primarily through the slow processes of weathering and erosion, during which carbon in rocks is released into the atmosphere.

Another set of slow geological processes returns the carbon to the Earth's crust: In certain environments dead organic matter accumulates and is buried under layers of sediment. As more layers accumulate, the underlying organic matter is compressed. The pressure, combined with other geological processes, slowly transforms the accumulated carbon-rich organic material into sedimentary rocks, storing that carbon securely underground for millions of years. In some circumstances, when specific conditions are present, the organic matter undergoes further chemical changes to become coal, oil and gas (methane). Carbon also moves between the crust and the upper mantle through the subduction of tectonic plates and conversely through volcanic activity. There is also a slow cycling of carbon within the ocean, with carbon moved from

the upper layers to the deep ocean, and the accumulation of carbon in marine sediments of zooplankton and phytoplankton.

The slow carbon cycle plays out over a very long timeframe. It took millions of years for carbon-rich sedimentary rocks and fossil fuels to form, storing away vast amounts of carbon deep in the earth's crust.

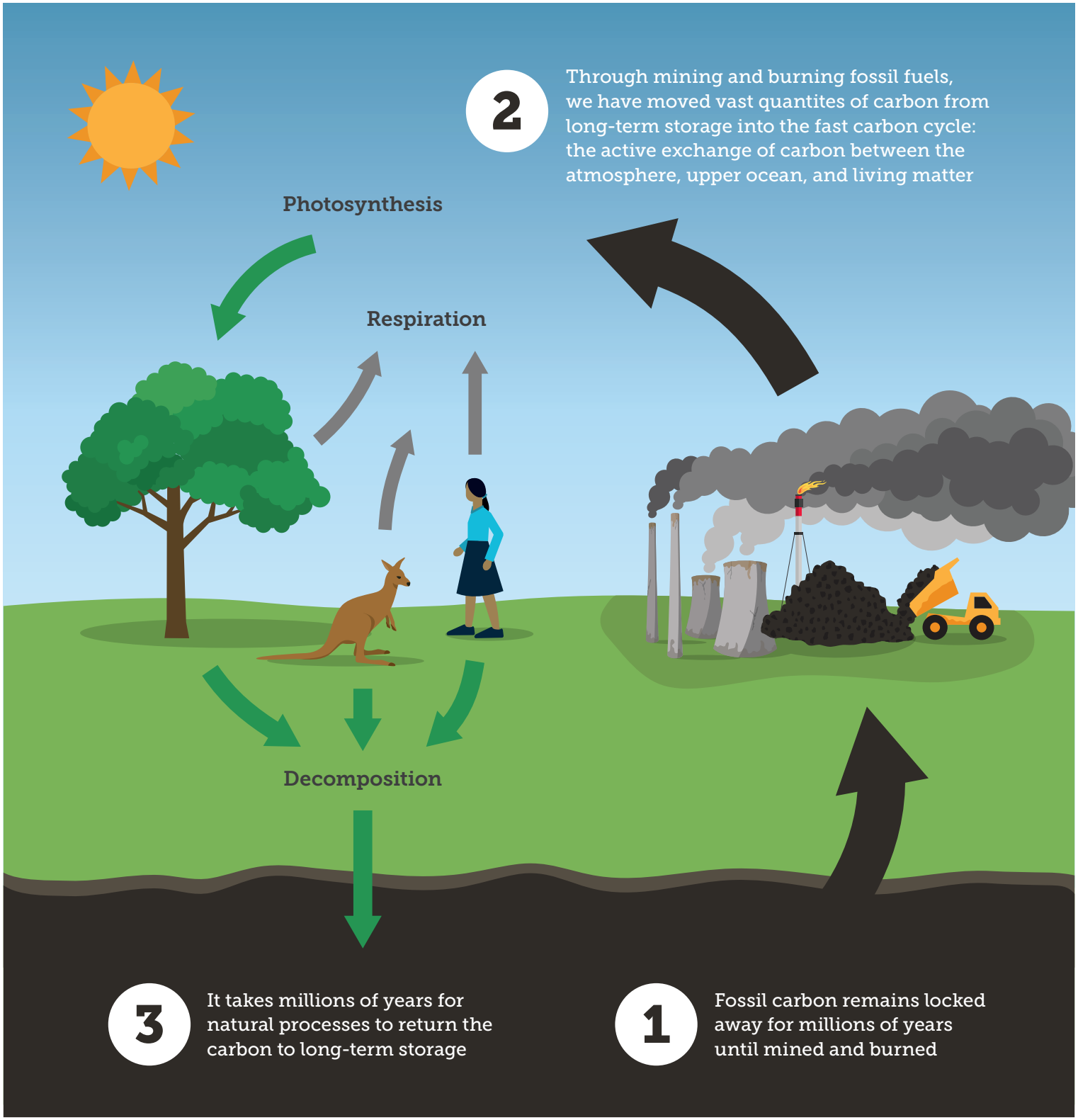
By digging up and burning fossil fuels like coal, oil and gas we have, in a very short period of time, profoundly altered the Earth's carbon cycle by moving huge quantities of carbon out of long-term storage. We have substantially increased the concentration of CO_2 in the atmosphere, trapping more heat from the sun, and raising temperatures faster than at any time in the geological record. Recent warming has been more than ten times faster than the average rate of warming coming out of an ice age.

In addition, much of the 'new' carbon that we've introduced to the fast carbon cycle through the burning of fossil fuels has been absorbed by the ocean, making it more acidic. To compound the problem, we have cleared huge tracts of forest, reducing the amount of carbon being absorbed by terrestrial ecosystems, adding even more carbon as heat-trapping gases in the atmosphere and as carbonic acid in our oceans.

Working from this understanding of the carbon cycle, it is time to lay bare some persistent myths and dangerous false solutions that are holding back genuine climate action in Australia, and to reaffirm the true scale of action required. In 2023 we no longer need to convince large sections of the population and our most powerful political figures that climate change is hurting us now. However, the risk of climate *delay*, based on genuine or wilful ignorance of the true nature of the challenge, is still very real and very dangerous.

It took millions of years for carbon-rich sedimentary rocks and fossil fuels to form; storing vast amounts of carbon. By digging up and burning coal, oil, and gas we've profoundly altered the Earth's carbon cycle in a very short time.

Figure 7: A simplified diagram of the carbon cycle. By burning fossil fuels we are putting carbon into the atmosphere that had been securely stored underground for millions of years. It will take millions of years for natural processes to return this carbon to long-term storage.



3.2 We can't offset our way out of trouble

Our first reason for taking this detailed look at the carbon cycle is to debunk a dangerous and pervasive myth standing in the way of rapid climate action in Australia: the idea that we can 'offset' emissions from the continued burning of fossil fuels. In reality, we can't carry on burning fossil fuels, including gas, and somehow make up for it by storing some carbon emissions elsewhere, either by way of 'nature-based solutions' such as planting more trees, or by somehow directly capturing and securely storing the carbon. That's equivalent to trying to extinguish a fire while at the same time throwing more fuel on the flames.

One tonne of carbon released from long-term storage through the burning of fossil fuels is *not* offset by one tonne of carbon being absorbed by planting trees, restoring wetlands or other land-based offset schemes. It's not an equal exchange - and it doesn't balance out.

That is because carbon is being released from long-term, stable storage underground (out of the slow carbon cycle) when we dig up and burn fossil fuels. Whereas when we store carbon in soil, or forests, that is part of the fast carbon cycle. It remains part of the active exchange of carbon between land-based ecosystems, the upper ocean and our atmosphere, and may not stay stored in the land for long. Forests may be destroyed by fire, disease, floods or droughts – all of which are increasing with climate change – quickly returning the carbon to the atmosphere (Morgan 2023).

There is no prospect that carbon capture and storage (CCS) and carbon capture, utilisation and storage (CCUS) technologies can deal with the vast majority of emissions that would result from continued dependence on fossil fuels. Therefore, while these technologies may play a limited role in capturing *residual* emissions from essential industries such as steel and cement where there isn't yet a low- or zero- emissions alternative available, they are no substitute for determined efforts to cut out the use of fossil fuels (Climate Council 2016, 2023g).

Any expansion of coal, oil and gas is adding to the problem we're trying to solve. We need to keep fossil fuels in the ground, and try to phase out what we're already using as quickly as possible.

You can't argue with the laws of physics, or climate science. Yet despite these realities, governments and corporations, including the Australian Government, plan to use offsets extensively in their pursuit of net zero emission targets. Whereas, when it comes to the science and the way our planet works, we must leave fossil fuels like coal, oil and gas in the ground and achieve genuine emissions reductions by getting as close to *real* zero emissions as soon as possible.[1]

CLIMATE COUNCIL RECOMMENDS

Climate Council recommends that Australia's emissions reduction targets be based on genuine emissions reductions. The use of offsets must be minimised and accounted for separately, in order that we are measuring and transparently accounting for real and effective efforts to limit climate damage.

BOX 2: CARBON CAPTURE AND STORAGE

Carbon capture and storage (CCS) technologies aim to capture emissions from industrial processes like fossil fuel extraction and processing. Once captured, the carbon is transported via pipeline or other means to where it can be injected into underground storage sites including certain rock formations and disused mines and gas wells. Carbon capture, utilisation and storage (CCUS) works similarly, but aims to re-use some or all of the captured carbon for other industrial or manufacturing processes, such as manufacturing building materials.

CCS and CCUS may have a role in capturing emissions from essential industrial processes for which we do not yet have clean alternatives. But when it comes to fossil fuels, they are a false solution and a dangerous distraction.

After decades of development and billions of dollars in investment, CCS remains expensive and there is no evidence it will ever be able to capture more than a small fraction of emissions from fossil fuel use. The majority of greenhouse gas emissions come from the burning of coal, oil and gas for energy – dwarfing emissions from the extraction and processing of these fuels. Globally, only two coal-fired power stations have ever used CCS technology at scale (Garcia Freites, Jones 2021). Currently, the world's CCS plants capture around 0.1 percent of emissions from fossil fuels. Even if we were one day able to capture and store emissions from many more large power plants, we would still be unable to deal with many other sources of emissions from fossil fuel combustion, such as the millions of car exhaust pipes and gas cookers. The bottom line: CCS must not be used to justify the extraction of more fossil fuels. We need to leave them in the ground.

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1 The IPCC has concluded that for a pathway that provides a 67 percent probability of limiting warming to 2°C, about 80 percent of coal, 50 percent of gas, and 30 percent of oil reserves cannot be burned. Significantly more must remain unburned if we are to limit warming to 1.5°C (IPCC 2023).

2 Based on the capture capacity of operational CCS plants being around 37 $MtCO_2$/year (Garcia Frietes, Jones 2021) and global fossil fuel emissions being 36.3 ± 1.8 $GtCO_2$ in 2021 (Friedlingstein et al. 2022).

3.3 Beyond net zero: the challenge of drawdown

Our second reason for returning to the basics of the global carbon cycle is to emphasise that achieving net zero emissions – or rather, as close to real zero emissions as possible – is just one step on our journey.

Before the Industrial Revolution, the concentration of greenhouse gases was around 280 ppm (parts per million) for several thousand years of human civilization. By burning fossil fuels, along with deforestation and other land use changes, humans have substantially altered the Earth's carbon cycle. As explored in this chapter, we have not only released massive amounts of carbon into the atmosphere, we have also shifted the balance of carbon stored underground in the Earth's crust and the amount actively circulating between the atmosphere, ocean and living matter.

Since 1750, humans have generated around 1.5 trillion tonnes of CO_2 emissions. Remarkably, more than half of that has been added since 1990 – when the First Assessment Report was published from the IPCC, by which point the world was fully informed of the dangers of climate change. Today, we have raised the concentration of CO_2 in the atmosphere to well over 400 ppm, which is more than a 50 percent increase over pre-industrial times.

Once we reach net zero emissions, we will have finally stopped adding to the problem, but we will still have to deal with the vast amounts of excess CO_2 and other greenhouse gases that have accumulated in the atmosphere.

When we reach as close to real zero emissions as possible, we will have stopped worsening the crisis. However, we'll still have to find ways to undo the damage that's already been done by drawing carbon back out of our atmosphere.

Figure 8: Lachlan Mitchell (21, on boardwalk), Matthew Skeene (20) and Ashlyn Skeene (21), Yirrganydji rangers collecting mud samples for research investigating the blue carbon storage potential of mangrove systems. Securing a safe and liveable climate will mean removing large amounts of carbon from the air, including through nature-based solutions.

A look back into the Earth's past tells us that even sustained warming of between 1.5°C and 2°C will likely trigger a major reconfiguration of our coastlines and our weather patterns (IPCC 2021c, Gergis 2022, Armstrong McKay et al. 2022).

In addition to conclusions drawn by the IPCC based on our knowledge of past climate, one stark illustration of what is at stake was provided this year by a new study on the Greenland ice sheet. Until fairly recently, climate scientists assumed that the Greenland ice sheet had remained largely intact for millions of years. However, recent findings indicate it may be more fragile and sensitive to climate change than previously thought. Analysis of frozen soil from under the Greenland ice sheet has revealed that large parts of Greenland were ice free 400,000 years ago (Christ et al. 2023) when the Earth was estimated to be about 1.5°C warmer than the pre-industrial era, a little above today's global warming of 1.2°C. Assuming that warming of 1.5°C will again melt that ice, this would add more than 1.4m to global sea levels (Christ et al. 2023). Should the Greenland ice sheet melt entirely, seas would rise around 7m – covering land that today is home to hundreds of millions of people.

Put simply, a world in which the concentration of CO_2 in the atmosphere remains above 400 ppm for an extended period, and in which temperatures have risen by 1.5°C or more above the pre-industrial level, is a vastly different world to that to which we are accustomed. Securing our future therefore depends not only on reaching net zero emissions as soon as possible, but also on undoing the damage through embarking on a massive project of climate and ecosystem restoration. This means finding ways to remove large amounts of carbon from the air and put it back into long-term storage – a process known as drawdown. It's a Herculean task that the world is only just beginning.

BOX 3: CARBON DRAWDOWN

By burning fossil fuels and clearing forests we have substantially increased the concentration of greenhouse gases in the atmosphere. Reaching net zero emissions is the first step, and will mean we have stopped adding to the problem. But to secure a safe and liveable future, we also need to remove large quantities of accumulated greenhouse gases. This is known as drawdown.

Carbon drawdown can be achieved to some extent by planting trees and restoring degraded natural environments so that they absorb and store more carbon. While important, these nature-based approaches have limitations both in their scale and permanence. For instance, there is only so much land available. Moreover, at any point forests may be lost to fires, disease, floods and drought - all of which are increasing with climate change. So we will need to do far more than reforestation.

Other solutions under development can help. One example is enhanced rock weathering, which works by accelerating the natural process of rock weathering to convert atmospheric carbon into land-based minerals. Rocks such as basalt are crushed into smaller pieces and then spread out over large areas of land. The rock reacts with atmospheric carbon dioxide to form stable carbonate minerals, thereby storing the carbon. Two recent major studies, by CSIRO (2022) and the Australian Academy of Science (2023), have begun exploring the wide range of carbon removal opportunities available in Australia.

The scale of drawdown required this century and beyond is gargantuan (IPCC 2021a). Safe, reliable and scalable techniques for drawdown need to be developed, deployed and scaled rapidly. Such technologies can help us undo the damage, but will not allow us to continue to burn fossil fuels and produce even more harmful greenhouse gas emissions. We must employ every effort to stop adding to the problem by rapidly cutting emissions, and then use drawdown technologies to clean up existing greenhouse gas pollution.

4. Escalating risks: What the latest climate science tells us

> *"We need all hands on deck for faster, bolder climate action. A window of opportunity remains open, but only a narrow shaft of light remains... We are getting dangerously close to the point of no return. The global climate fight will be won or lost in this crucial decade – on our watch. One thing is certain: those that give up are sure to lose. So, let's fight together – and let's win."*
>
> - UN Secretary General Antonio Guterres, 2022.

4.1 Understanding risk

When facing a challenge as grave and as far reaching as the climate crisis, the only rational response is to do everything in our power to limit harm, and reduce the risks of a truly cataclysmic outcome.

Addressing climate change means dealing in risks, probabilities and uncertainties. Yet almost always our response ends up playing the highest risk game possible; by betting on a best-case scenario and conveniently ignoring the extraordinary gamble we are taking on our collective future. When weighing up the risks of operating on a patient against a possible, better outcome a doctor would never gamble with their patient's life. Similarly, it is unacceptable for anyone to take steps that mean the worse-case scenarios for humanity are possible. To protect what we love and what we need we must do better - acknowledge and understand the threats at hand, and work to eliminate the worst of them.

The range of plausible futures resulting from past and present failures to respond adequately to the climate crisis includes the truly nightmarish: mass extinction, collapse of human societies, and unimaginable suffering. While there is significant debate over the likelihood of such scenarios, their very possibility should compel us to do everything in our power to avoid them (Kemp et al. 2022).

Getting to grips with the task ahead demands facing up to all risks and talking honestly about the fact that our existing approach to climate change leaves us all dangerously exposed to harm.

Already, at global warming of around 1.2°C, we are witnessing the destruction of critical ecosystems and communities pushed to their limit by extreme heat, fire, storms and floods (IPCC 2022a). Put simply, there is no 'safe' level of warming. With every increment of additional warming, the risks from extreme weather escalate, as does the possibility of crossing 'tipping points' that would trigger even more abrupt and potentially irreversible changes (see section below).

Under the *Paris Agreement* countries, including Australia, committed in 2015 to hold warming to well below 2°C and to pursue efforts to limit the temperature increase to 1.5°C; recognising that limiting to 1.5°C would "significantly reduce the risks and impacts of climate change" (UNFCCC 2015). The inclusion of the 1.5°C goal was a hard-won victory for the world's most vulnerable countries, including Pacific Island nations which for decades have understood the existential challenge of climate change and had campaigned hard for a stronger temperature goal. Subsequent science has strongly affirmed that warming beyond 1.5°C is extremely risky for humanity, with the dangers increasing with every fraction of a degree of further warming (IPCC 2018, 2023).

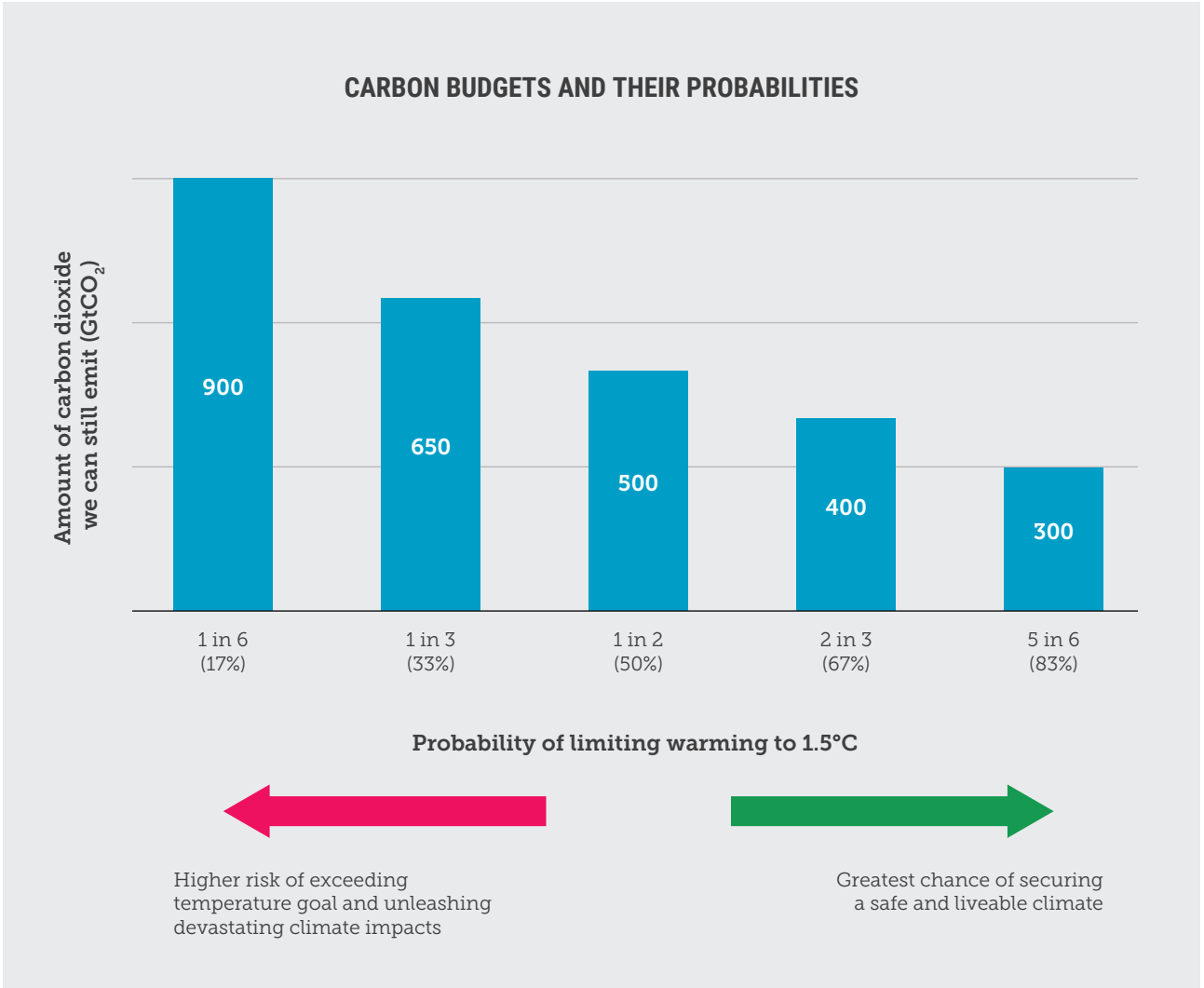
Alignment with the goal of limiting warming to 1.5°C has therefore become the key measure for the adequacy on any emissions reduction target. However, it is important to understand the calculations that underlie temperature and emissions, and why we must always aim for the strongest possible emissions reductions.

If we know better, we can do better. There's no safe level of global warming, and the worst-case scenarios are still possible. We need to do much more to eliminate truly nightmarish outcomes.

CARBON BUDGETS

A carbon budget is the maximum amount of greenhouse gases that can be released into the atmosphere while still having a chance of limiting the global average temperature to a given level. Like many aspects of climate science, the science of carbon budgets involves probabilities. For example, we can estimate a budget that provides a 50 percent probability of limiting warming to 1.5°C; which is a one-in-two chance. If we want a higher likelihood of limiting warming to 1.5°C, say a two-in-three chance (or 67 percent probability) then the budget (the amount of carbon that can be emitted) becomes smaller.

Figure 9: For a greater chance of limiting warming to 1.5°C, and thereby a greater chance of avoiding the disastrous impacts of exceeding this target, we must start with a smaller carbon budget. Carbon budget figures are from IPCC 2021a.



Owing to decades of failure to adequately reduce emissions, the remaining global carbon budget for a high chance of limiting warming to 1.5°C by the end of this century is either now extremely small or is already exhausted (see Chapter 6). Claims of '1.5°C compliance' are usually therefore based on a 50 percent likelihood (or coin's toss chance) of limiting warming to 1.5°C. Furthermore, today almost all scenarios that see us limiting warming to 1.5°C involve a period of temporary 'overshoot' (IPCC 2021a). In other words, temporarily exceeding warming of 1.5°C but then bringing the temperature back down through removing enormous quantities of greenhouse gases from the atmosphere. This involves the large-scale use of carbon dioxide removal technologies and the restoration of ecosystems.

Beyond the assumed level of risk (that is, probability of success), estimates of the available carbon budget depend on the specific models used, our understanding of the sensitivity of the climate system, and a wide range of additional assumptions (see Chapter 6 and Appendix). Whatever the assumptions in the carbon budget calculations, it is abundantly clear that any remaining chance of eventually limiting warming to 1.5°C – and accepting this will involve a period of overshoot – requires truly transformative change, including roughly halving global emissions this decade (IPCC 2018, 2021a). That requires progress at a scale, scope and pace far greater than what we are witnessing (UNEP 2022). Nonetheless, when dealing with truly existential risks, and given what we know about the dangers of every additional increment of warming, retaining a coin's toss chance of limiting warming to 1.5°C should be the absolute floor to our aspirations, not a ceiling. We should be aiming to limit warming as far as possible, and with the highest probability of success.

Would we board a plane if we knew there was a 50 percent chance of it falling from the sky? Of course not, we would find a safer way to travel. In the same way, the future of our planet is too important to leave up to a coin toss.

Figure 10: Firefighter battling a blaze in Queensland in 2007. Australia has seen an increase in extreme fire weather, and a longer fire season, across large parts of the country since the 1950s due to climate change (BoM and CSIRO 2022).

CLIMATE COUNCIL RECOMMENDS

Recognising the enormous risks of warming beyond 1.5°C, Climate Council recommends that Australia's emissions reduction targets aim to limit warming as far as possible and with the highest probability of success. This means aligning as close as possible with a budget that provides a 67 percent chance of limiting warming to 1.5°C.

4.2 'Stunned by the ferocity'

> *"What is playing out all over the world right now is entirely consistent with what scientists expect. No one wants to be right about this. But if I'm honest, I am stunned by the ferocity of the impacts we are currently experiencing."*
>
> - Dr Joëlle Gergis, 2023.

The upward march in global average land and sea surface temperatures is remarkably consistent with what climate modellers have long projected. This has been likened to a staircase, with global temperatures rising steadily and consistently over time, but jumping around from year to year.

The true impact of climate change is felt not through this steady rise in the average temperature and the total amount of energy being absorbed by our atmosphere and ocean, but rather through the sudden and severe events that this creates: mega fires, destructive storms, and deadlier heat waves. It is in these frightening extremes that climate models have often failed to fully capture the brutal reality of climate change. Communities have been caught off guard, and often overwhelmed. Even climate scientists have been left stunned by the ferocity of what they're observing.

July 2023 saw intense and persistent heatwaves in the southwest of the United States, southern Europe and China. Many heat records were broken, with temperatures exceeding 50°C in California and China. Phoenix, Arizona endured 31 consecutive days of maximum temperatures over 43°C (BBC 2023a). Rapid analysis by World Weather Attribution deemed these dangerous events as extremely rare or "virtually impossible" in the absence of climate change, and no longer rare in today's climate (Zachariah et al. 2023). Globally, July was the hottest month ever recorded and the first month in which the global average temperature rise spiked to 1.5°C above pre-industrial levels.[3]

Climate change is measured in global average temperatures, which steadily rise over time. We experience it via the sudden and severe events that it worsens: mega fires, destructive storms, and deadlier heatwaves.

3 Note that breaching 1.5°C over a single day, month or year does not equate to exceeding the 1.5°C temperature goal as defined by the Paris Agreement and the IPCC. The goal is based on temperatures averaged over 20 or 30 years. (30 years is the standard reference period used by the World Meteorological Organisation. However, the most recent IPCC assessment used a reference period of 20 years.)

Figure 11: A couple in Brisbane move their belongings by boat during the March 2022 floods. A warmer atmosphere can hold more water and has more energy to fuel intense storms, increasing the risk of extreme downpours.

As temperatures soared, many countries suffered through devastating fires. By June, Canada was suffering the worst wildfire season in its recorded history, affecting every province. By August, fires had burned through about four percent of Canada's forests – more than six times the average for this time of year (CIFFC 2023). Smoke blanketed many Canadian towns, forced the cancellation of outdoor events, and forced more than 120,000 people to evacuate their homes (New York Times 2023). Meanwhile, hundreds of kilometres away in New York, schools were closed and flights grounded as the city was blanketed in smoke from Canadian fires. On the other side of the Atlantic, wildfires were raging across many countries of southern Europe and north Africa, including Algeria, Tunisia, Greece and Italy. Fires on the Greek island of Rhodes forced the largest fire evacuation operation in the country's history (The Guardian 2023a). In August, the island of Maui in Hawaii suffered "the worst natural disaster that Hawaii ever faced", when the town of Lahaina was destroyed by a fast-moving blaze (The Guardian 2023b). At time of publication, 115 people in Maui had been confirmed dead.

Between global headlines about heat and fire came stories of extreme downpours and floods. In Korea in July, flash floods and landslides caused by torrential downpours left dozens dead and thousands displaced, while damaging tens of thousands of hectares of farmland and killing nearly a million livestock (Yonhap News Agency 2023). Meanwhile, in north India, just a couple of months after a record breaking heatwave affected many countries in the region, intense monsoon rains caused severe flooding and landslides. With climate change the Indian monsoon is becoming more erratic, increasing the risk of deadly storms (Vaidyanathan 2023). Further east in China, and just two weeks after the country logged its highest ever recorded temperature, with a high of 52.2°C in the northwest, Beijing and surrounding Hebei province were struck by deadly downpours. Beijing saw its heaviest rainfall on record and more than a million people were evacuated (CNN 2023).

Put simply, we are now living through an age of consequences for our past inaction on climate change. With 2023's many extreme events, just as with our Black Summer fires of 2019-20 and floods of 2022, we are watching in real time as the impacts of relentlessly burning fossil fuels and ignoring the scientific warnings unfold.

4.3 Our ocean: coming back to bite us

> *"By absorbing all this heat, the ocean lulls people into a false sense of security that climate change is progressing slowly. But there is a huge payback. It's overwhelming when you start to go through all the negative impacts of a warming ocean. There's sea level rise, coastal inundation, increased floods and drought cycles, bleached corals, intensification of cyclones, ecological impacts, melting of ice at higher latitudes in the coastal margins — that gives us a double whammy on sea level rise. The oceans have stored the problem but it's coming back to bite us."*
>
> - Professor Matthew England, 2023.

Alongside record land temperature records, devastating fires and extreme downpours, 2023 has also laid bare the stark reality of our changing ocean. The year has seen extreme ocean temperature anomalies, particularly in the Atlantic region, and an astonishing decline in Antarctic sea ice. It has also brought alarming new insights into how climate change may be affecting ocean circulation and currents – a lifeblood for all living systems.

Understanding changes in our ocean and cryosphere (the frozen parts of the planet) is crucial to understanding climate change and what may lie ahead.

The ocean, which covers around 70 percent of the Earth's surface and has an average depth of about 3,700 metres, stores vast amounts of energy and is the engine of the Earth's climate system (IPCC 2019).

Water has a much higher heat capacity than air. To heat a cubic metre of sea water by one degree Celsius requires around three thousand times the amount of energy it takes to heat a cubic metre of air by the same amount.[4] This immense capacity to absorb and store heat means that the vast majority – around 93 percent – of the excess heat in our climate system from greenhouse gas emissions has been absorbed by the ocean

4 Assuming a density for air of 1.2kg/m3 – the approximate density of air at sea level – and a heat capacity of 1 J/g/K; and a density for sea water of 1,025kg/m3 and a heat capacity of 3.85J/g/K.

(IPCC 2019). The rate of ocean warming has increased dramatically in recent decades (Cheng et al. 2023). Today, we are putting more than 10 zeta joules of extra heat energy into the ocean each year. That's the equivalent energy of five Hiroshima bomb explosions every second or 150 million each year (Cheng et al. 2022, Cheng et al. 2023). Rising greenhouse gases and escalating climate change are also changing the ocean's chemistry, making it more acidic and less oxygen-rich (IPCC 2019).

These ocean changes affect our weather and climate. Natural cycles in our weather patterns, for example between periods that are generally cooler and wetter than average and those that are hotter and drier, are influenced by patterns in ocean surface temperatures. Understanding how climate change influences natural climate drivers including the El Niño-Southern Oscillation is a complex area of science (IPCC 2021b). However, recent research led by Australian scientists has concluded that strong El Niño and La Niña events are already occurring more frequently as a result of climate change (Cai et al. 2023).

Australia's climate is already highly variable from year to year and prone to periods of drought followed by extremely wet conditions. During wet periods, we not only see higher risk of floods but also large growth in vegetation. When the rains disappear this vegetation dries out, priming the landscape to burn. An increase in the frequency of strong El Niño and La Niña events means more pronounced swings between periods that are wetter than average and those that are drier. This increases the chances of devastating floods, following shortly after or before deadly heatwaves, and extreme fire conditions. In 2023, Australia is already facing this reality, as we switch from a protracted La Niña event to the return of El Niño conditions (Climate Council 2023b).

In August 2023, following weeks of reports of record high ocean surface temperatures in multiple regions, the world set a new record for the average daily global sea surface temperature (BBC 2023b). Remarkably, August is not typically one of the warmest months for the global ocean, with the highest average sea surface temperatures typically recorded in March. Meanwhile, in Antarctica, an even more striking event has been unfolding.

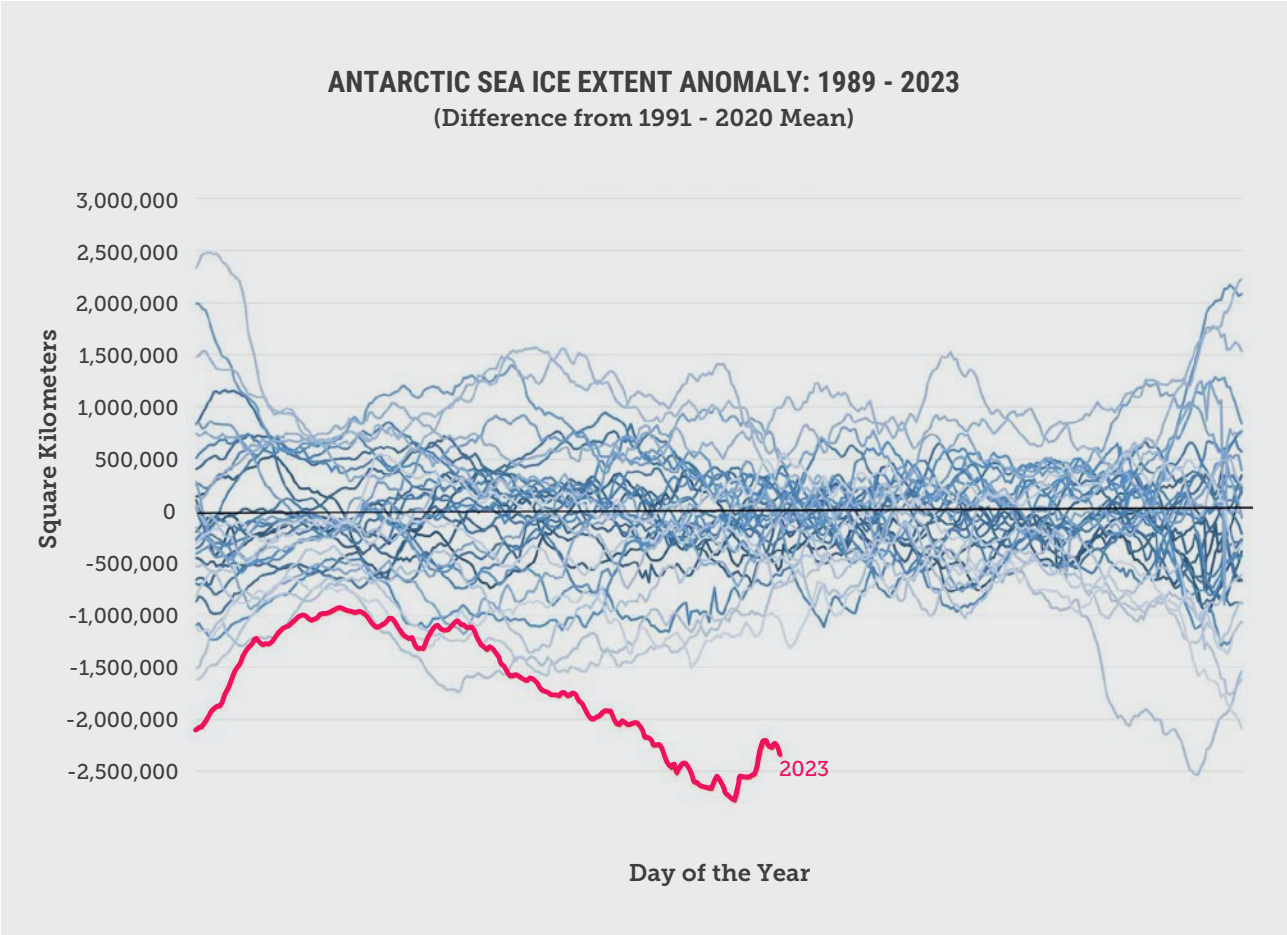
The rate of ocean warming is mind-bending. Every second, oceans are storing excess energy equivalent to five Hiroshima bombs.

SEA ICE AND THE ANTARCTIC

The area of sea ice around the Antarctic changes significantly across the course of a year, between the southern hemisphere's summer and winter. After reaching its minimum extent around March, the sea surface begins to freeze again and the area of sea ice peaks around September before beginning to thaw and retreat again. However, this year the sea ice was much slower to recover. By late June, the total area of sea ice was 2.44 million km^2 below the mean for that time of year, and 1.33 million km^2 below the previous record for this day of the year. For context, 1.33 million km^2 is an area around 20 times the size of Tasmania (Arctic Data Archive System 2023).

A reduction in the area of sea ice can lead to further ocean warming, which in turn leads to further ice melt. This is known as a feedback loop. When solar energy hits the bright surface of sea ice, much of it is reflected back into space. When that ice disappears and the solar energy is instead hitting the dark open water surface, less is reflected back into space, instead being absorbed into the ocean.

Figure 12: The seas around Antarctica were very slow to refreeze this year. This graph shows the amount by which the area of sea ice has deviated from the mean for that time of year, with previous years shown in blue and 2023 shown in red.
Source: Professor Eliot Jacobson, based on data from the Arctic Data archive System.



5 While the latest data on Antarctic sea ice extent is striking, we should note that the Antarctic has a more complex response to climate change than the Arctic. While polar scientists have been watching recent consecutive years of below-average Antarctic sea ice extent with considerable alarm, it may take several more years before they are confident there is a persistent downward trend.

OCEAN CIRCULATION

Beyond record high ocean temperatures and an alarming decline in Antarctic sea ice, 2023 also brought new evidence of how climate change is affecting ocean circulation and currents. Recent observations show that circulation in the deep waters around Antarctica has slowed by around 30 percent since the 1990s (Gunn et al. 2023).

As Antarctic waters freeze they expel salt, causing surrounding waters to become more dense. Every year, trillions of tonnes of cold, dense, salty and oxygen-rich water sinks near the coast of Antarctica. This sinking drives the deepest flows of the overturning circulation – a network of currents spanning the world's oceans. Rising temperatures and melting ice are disrupting this process, and the circulation is slowing.

Ocean circulation and currents regulate the distribution of heat, carbon, oxygen and nutrients around the globe, influencing climate, sea levels, and the health of marine ecosystems. The slowdown in this circulation could accelerate ice loss and sea level rise, reduce the ocean's ability to absorb carbon (leaving more greenhouse gases in the atmosphere), shift the location of tropical rainbands, and deprive ecosystems near the surface of nutrients, damaging fisheries.

Ocean scientists have long warned of possible declines in ocean circulation due to climate change. While models had predicted a decline in circulation in the deep waters around Antarctica (Li et al. 2023), recent observations suggest it may be happening faster than projected.

2023 also saw concerns raised about the state of the Atlantic meridional overturning circulation (AMOC). The AMOC is regarded as a major tipping element in the climate system, the collapse of which would have major and potentially disastrous knock-on effects (see next section for more on tipping elements). In its Sixth Assessment Report, the IPCC concluded that while possible, a full collapse of the AMOC was unlikely to occur this century (IPCC 2021a). However, a new study in 2023 estimated that under the current trajectory of global emissions, the AMOC could collapse around 2050 (Ditlevsen and Ditlevsen 2023).

Studies such as this must be seen in the right context – as outliers that challenge our best estimates of where things are headed. However, their very existence as possibilities are so grave that they must be avoided at all costs with accelerated efforts to tackle the climate crisis.

4.4 Tipping points

> *"A growing threat is the approach of 'tipping points' – thresholds which, once crossed, trigger irreversible changes, such as the loss of Amazon rainforest or the West Antarctic ice sheet. Some tipping point thresholds have already been reached, while others are getting closer as global warming continues. Once tipped into a new state, many of these systems will cause further warming - and may interact to form cascades that could threaten the existence of human civilisations."*
>
> - Professor Tim Lenton, 2023.

Over the years, as our understanding of human impact on the climate system has developed, our situation has become progressively more urgent. Impacts are occurring at lower temperature rises than previously projected and the pathway to avoiding catastrophe looks increasingly narrow and fraught.

This point has been driven home by our understanding of tipping points.

A growing body of research has warned that the Earth System contains 'tipping elements', which once pushed beyond a certain threshold – known as a 'tipping point' – may undergo abrupt, non-linear and irreversible changes. These tipping elements include the polar ice sheets; large ecosystems such as the Amazon rainforest; and circulation patterns such as the ocean currents that distribute heat around the globe.

The consequences of crossing these tipping points would be catastrophic. For example, the collapse of major ice sheets on Greenland, West Antarctica and part of East Antarctica would commit the world to around 10 metres of irreversible sea level rise (Lenton et al. 2019). The loss of rainforests or the thawing of permafrost would result in additional release of greenhouse gases, amplifying global warming. Collapse of major land or ocean ecosystems such as tropical coral reefs would reverberate throughout the biosphere, affecting all life.

Tipping points lead to abrupt, major and irreversible changes to our Earth System. With every incremental increase in global warming we get closer to crossing these thresholds. The consequences are catastrophic, and must be avoided at all cost.

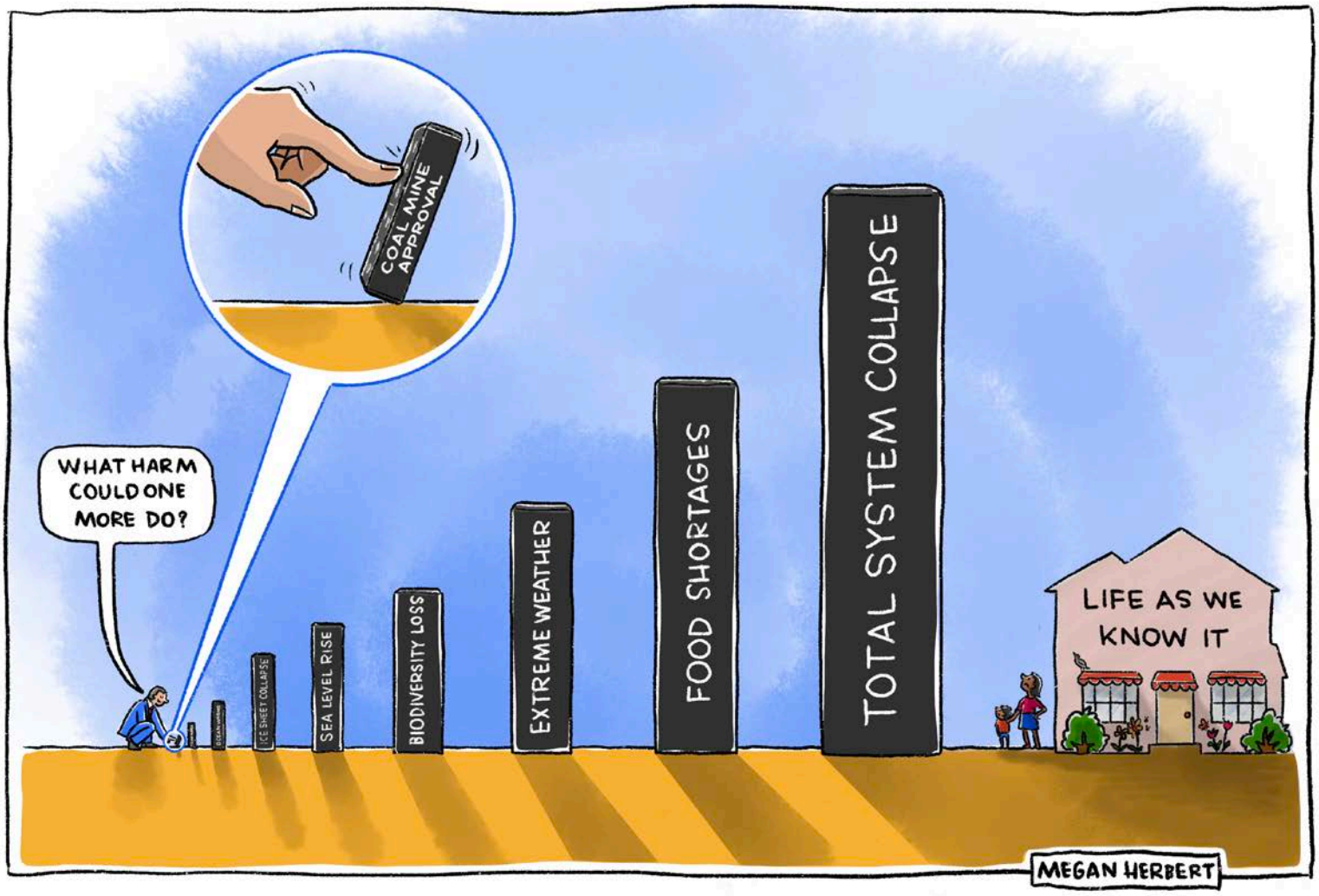


Figure 13: The Earth System contains tipping elements, which once pushed beyond a certain threshold – known as a tipping point – may undergo abrupt and irreversible changes. These tipping elements include ice sheets, large ecosystems like the Amazon rainforest, and ocean currents. The tipping of one or two could lead to a cascade, with catastrophic consequences for human societies. (Cartoon drawn for Climate Council by Megan Herbert.)

When the IPCC first introduced the idea of tipping points in the Earth System over two decades ago, these 'large-scale discontinuities' as they were then called, were only considered likely if warming exceeded 5°C. Today, it is clear that abrupt and irreversible changes such the collapse of major ice sheets or the rapid decline of coral reefs could be triggered at much lower temperatures (Climate Council 2021b, Armstrong McKay et al. 2022).

In 2008, a group of leading climate scientists identified nine key tipping elements in the Earth System (Lenton et al. 2008). Just over a decade later, they warned that more than half of these tipping elements – including the Greenland ice sheet and Arctic sea ice – were now 'active' (Lenton et al. 2019).

A recent review paper suggests that even at today's level of warming it is possible that we have crossed tipping points for the Greenland ice sheet, West Antarctic ice sheet and tropical coral reefs (Armstrong McKay et al. 2022). At warming of between 1.5°C and well below 2°C – that is, within the *Paris Agreement* temperature goal – these and some other tipping points, including widespread and abrupt thawing of permafrost, become not merely possible but likely (Armstrong McKay et al. 2022).

Other studies suggest tipping points for some specific ecosystems may already have been crossed. The Black Summer fires of 2019-2020, when around 10 times the amount of forest burned than during a typical fire season, suggest we may already have crossed a tipping point for Australia's broadleaf and mixed forests (Boer et al. 2020, Climate Council 2021a). The succession of severe mass coral bleaching events along the Great Barrier Reef is another likely example of a tipping point being crossed (Climate Council 2021a).

In other words, today, with around 1.2°C of warming, it is clear that we are already at risk of triggering abrupt and irreversible changes in the climate system (Climate Council 2021b, Armstrong McKay et al. 2022). Moreover, we have come to better understand the connections between these tipping elements, and how the tipping of one or two, such as the loss of Arctic sea ice or the rapid thaw of permafrost, could contribute to the destabilising of others; creating a 'tipping cascade' (Climate Council 2021b, Armstrong McKay et al. 2022, Liu et al. 2023, Wunderling et al. 2023, Willcock et al. 2023). If such a scenario were to be set in motion, the Earth System would continue to warm until it reached a new stable state, regardless of our efforts to rapidly reduce greenhouse gas emissions. That new state would be much hotter than the climate of the past several thousand years, during which time our complex human societies have developed (Steffen et al. 2018, Lenton et al. 2019, Climate Council 2021b.)

Notably, many of these tipping elements are not represented well, or in some cases not at all, in the models used for climate projections that have fed into the latest IPCC reports. This means that these models may fail to capture the true scope of changes and impacts associated with a given level of warming.

CLIMATE COUNCIL RECOMMENDS

Climate Council recommends that in setting emissions reduction targets, the Australian Government recognise the extreme and existential risks posed by tipping points in the climate system, and the need to do everything possible to eliminate the risk of catastrophic scenarios.

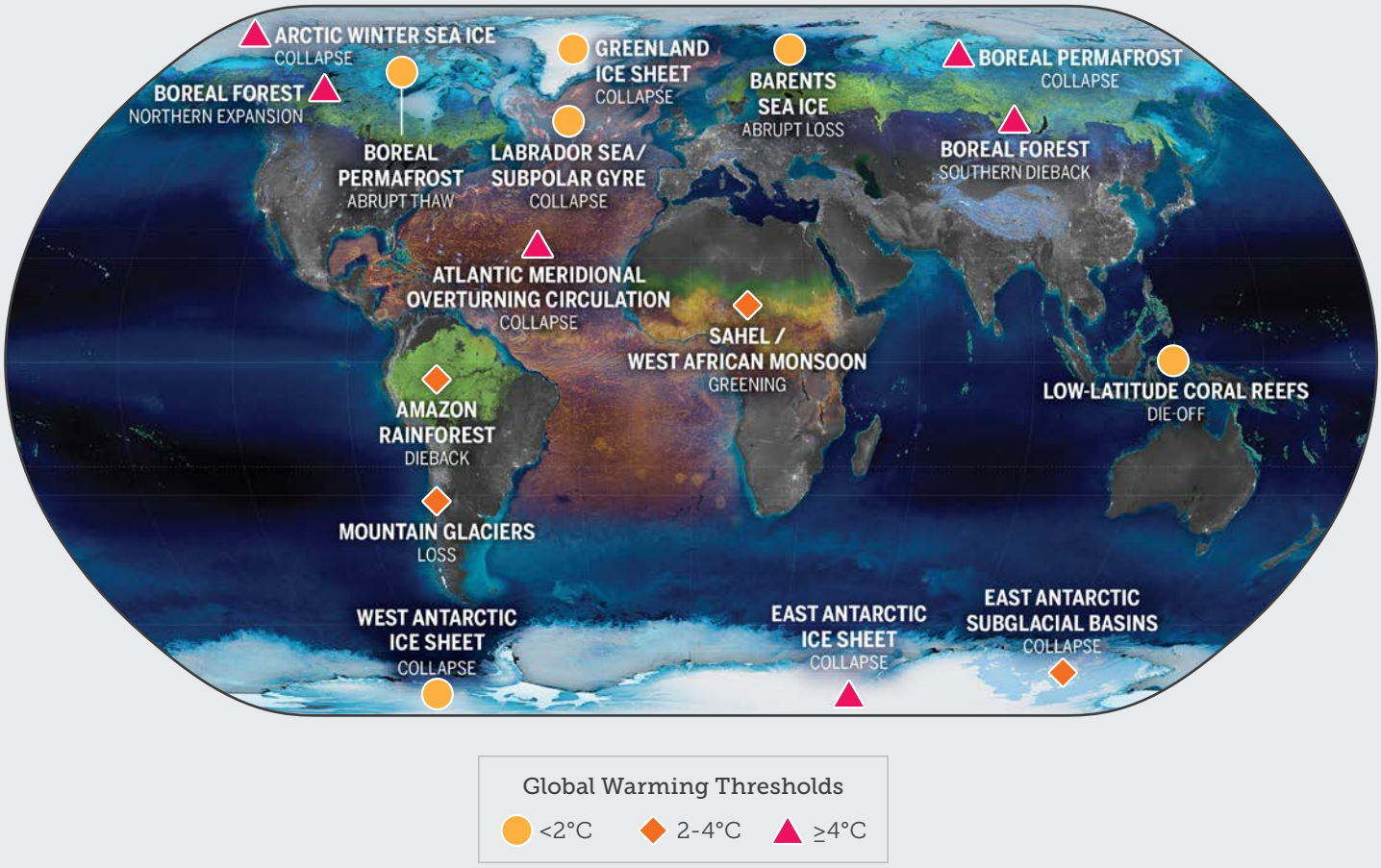


Figure 14: Tipping elements in the climate system, and the warming level at which their tipping point will likely be crossed. Tipping points for some elements, including tropical coral reefs and the West Antarctic ice sheet, likely lie below 2°C. **Source:** Adapted from Armstrong McKay et al. 2022.

In conclusion, after considering the risk built into carbon budgets and target setting, the escalating impacts of climate change, the future climate impacts being stored by our ocean, and the growing risk of transgressing tipping points, our only rational response is to try and cut our emissions as fast as possible. Anything less is an unacceptable gamble with our future.

5. Understanding Australia's role

> *"I have long said that we are all in the same canoe when it comes to combating climate change. While the climate emergency presents a new and frightening reality, if we paddle together, there is no challenge we cannot overcome."*
>
> - Prime Minister Frank Bainimarama, 2020

Incremental change is no longer enough. Tackling the climate crisis now requires an all-in effort. Our future depends on every country bringing their A game, and leaving it all on the field.

Like any country, Australia has its own particular set of opportunities and challenges when it comes to cutting emissions and creating a clean economy of the future.

OUR NATURAL RESOURCES

We are blessed with enormous amounts of sunshine and wind, creating vast untapped potential for renewable energy generation. We are also a high-income country with sufficient public and private capital to build the necessary clean energy system, transport solutions and industries of the future.

OUR INDUSTRIES

In the past, we built a significant portion of our national wealth off the back of fossil fuels and other high-carbon industries. Today, we are exceptionally well-endowed with opportunities for new clean industries like green steel, and critical minerals including downstream processing (Climate Council 2023d). Managing this change is undeniably complex, but our natural advantages in renewable energy to do so sets Australia apart from many other fossil fuel producing nations.

OUR CHOICES AND BEHAVIOURS

Australians have many opportunities to improve the way we use energy. At the moment, we are downright wasteful. Across the board – from household electricity usage to transport emissions to our diets and consumption of goods – our emissions per person are among the highest in the world. We can make major cuts in emissions while maintaining our high standards of living. Indeed, many of the climate solutions at our fingertips, including home energy efficiency and cleaner transport, offer many other benefits for our health, our communities, and our hip pockets (Creutzig et al. 2022; Climate Council 2022b, 2023e, 2023f).

OUR GLOBAL RESPONSIBILITY

As a counterpoint to Australia, a low-income or middle-income country such as Bangladesh or India face much greater challenges in curbing emissions without compromising basic needs. Per person, they are also starting from a much lower level of emissions.

In addition to taking account of our opportunities and capabilities for emissions reduction, it is vital for Australia and any country to also consider our historical responsibility for the climate crisis. In other words, how much we have collectively contributed to the problem. Australia not only has very high emissions today, but along with most other advanced economies bears a hefty responsibility for those which have already accumulated in the atmosphere. This is because Australia, along with most of Europe, North America and a handful of other regions and countries, began industrialising first, and have been emitting large quantities of greenhouse gases for longer. Australia is also a very large producer and exporter of fossil fuels.

The extent to which a country bears historic responsibility for climate change tends to closely mirror how much economic strength and resources it now has at its disposal to act on the crisis. Developed nations have more wealth and resources to deal with climate change, and that wealth has been built off the back of the very thing that caused it: fossil fuels. In contrast, countries that have contributed the least, including many of the world's small island nations and much of the African continent, tend to have fewer resources at their disposal, and may need to develop further in order to ensure the basic needs of their citizens are met. They are also typically more vulnerable to climate change; being hit first and hardest by its impacts, with fewer options to adapt.

Incremental climate action doesn't cut it. With everything on the line, Australia needs to throw the kitchen sink at climate change.

THE PARIS AGREEMENT

The *Paris Agreement* recognises these realities and all signatory countries including Australia committed to act accordingly. Countries promised to make the maximum possible effort towards achieving the global temperature goal and limiting climate impacts. Specifically, it requires countries to reflect their "highest possible ambition" (Article 4.3) within their Nationally Determined Contributions (NDCs), including their emissions reduction targets. The Agreement also requires each country's target to reflect its "common but differentiated responsibilities and respective capabilities, in light of different national circumstances" (Article 4.3). More specifically, it makes clear that "developed country parties should continue taking the lead" (Article 4.4). These key articles build on Article 3.1 of the UN Framework Convention on Climate Change (UNFCCC).

Lots of different ways have been proposed of calculating national efforts towards our global climate goal, but there is no universally accepted way. For example, some have argued that historical contributions should be counted since the start of the Industrial Revolution, while others think it is only reasonable to start at the time at which the world became widely aware of the dangers of greenhouse gas emissions (typically 1990). Some argue that a country's existing circumstances are a much more important consideration than its historic responsibility. Typically, each country has interpreted the UNFCCC's 'equity principles' in such a way as to justify a lower effort. This has contributed to today's combined commitments falling far short of the scale and pace of action required.

One thing is clear: a developed country like Australia needs to reduce our emissions at a significantly faster rate than the global average, and achieve net zero emissions earlier than most other countries.

Figure 15: Globally, 32 percent of the renewable energy workforce are women, compared to 22 percent for the energy sector as a whole (IRENA 2019). The energy transformation offers many additional benefits to society, including helping tackle long-standing inequalities.

To illustrate the point, let's assume that the world must roughly halve emissions this decade and reach net zero by 2050 – a commonly cited pathway that provides at best a coin's toss chance of limiting warming to 1.5°C. If Australia halved our emissions then each person in the country would still be contributing around twice the emissions of the global average, and around eight times the average for Pacific Island nations.

In the next chapter we look closely at the global carbon budget and argue that when it comes to Australia's domestic emissions – that is, those produced within our borders – Australia should aim to achieve net zero by 2035. However, to fully appreciate Australia's role in the global climate effort, we also need to consider our impact beyond national borders.

Australia is one of the world's largest producers and exporters of fossil fuels. Our exports of coal and gas result in more than twice our domestic emissions (The Australia Institute 2019). Fortunately, we have many opportunities to replace these fossil fuel exports with clean products. Doing so will not only ensure we play a major role in the world's decarbonisation efforts but also ensure Australia's ongoing economic security and prosperity (Beyond Zero Emissions 2021, Climate Council 2023d). Put simply, to date Australia has been an outsized part of the climate problem. Now, we are poised to play a major, positive role in the solutions. Doing so will mean leaving our coal and gas in the ground, and cleaning up our economy as quickly as possible.

CLIMATE COUNCIL RECOMMENDS

Australia's emissions reduction targets must represent a fair share of the global emissions reduction task. Our next Nationally Determined Contribution to the *Paris Agreement* must reflect Australia's historical responsibility for climate change, our economic capability, and our natural advantages in renewable energy.

6. Calculating our targets

In our 2021 report *Aim High, Go Fast,* the Climate Council concluded – based on the latest available science and taking into account Australia's high emissions and huge renewable energy resources – that Australia should aim to reduce emissions by 75 percent below 2005 levels by 2030 and reach net zero by 2035 (Climate Council 2021b).[6]

For this report, we have updated these calculations to take account of the conclusions of the IPCC's Sixth Assessment Report, the latest data on global emissions, and other recently published science (see Tables 1 and 2). This updated analysis strongly reaffirms our recommendation from 2021.

Given the extreme and escalating risks from climate change, and the narrow window remaining in which to avoid a truly catastrophic scenario, Australia must plan to reach net zero emissions by 2035.

Net zero by 2035 is a gargantuan task. We don't make the recommendation lightly, but this report makes very clear all that is at stake. As the calculations in this section show, there are strong grounds to argue for an even earlier net zero date. This is balanced, however, against what it is possible to do within the time that we have left.

6 Our conclusion was very similar to advice published earlier in 2021 by a group of Australia's top climate scientists including Professors Will Steffen, Lesley Hughes and Malte Meinshausen, who assessed that Australia should reduce our emissions to 74 percent below 2005 levels by 2030 and reach net zero by 2035 (Climate Targets Panel 2021). However, there were some small differences in the approaches taken by these two studies. The advice from the Climate Targets Panel was based on a 50 percent chance of limiting warming to 1.5°C and replicated the 'modified contraction and convergence' approach to effort sharing used previously by the Climate Change Authority. In *Aim High, Go Fast* (Climate Council 2021b) we took account of new science on carbon cycle feedbacks, including melting permafrost, emissions from the Amazon rainforest and emissions from boreal forests, resulting in a more stringent carbon budget. Our key recommendation – a 75 percent cut on emissions below 2005 levels and reaching net zero by 2035 – was based on a carbon budget for a 67 percent probability of holding warming to below 1.8°C.

GLOBAL CARBON BUDGET

Table 1, below, provides estimates of the remaining global carbon budget. In line with the risks outlined in Chapter 4 and the need to eliminate the worst-case scenarios as much as possible, we have further reduced the remaining budget to account for risks from carbon cycle feedbacks and from non-CO_2 gases. Further notes on the specific assumptions made are provided in the Appendix. Consistent with the conclusions reached in our 2021 report, a global carbon budget for a reasonable chance of holding warming to 1.5°C, with little or no overshoot, has already been almost completely exhausted. To hold warming to a peak of 1.7°C, global emissions need to reach net zero by the early 2040s.

Table 1: Global carbon budget.

	Two in three chance (67 percent probability) of limiting warming to 1.5°C		Two in three chance (67 percent probability) of limiting warming to 1.7°C	
Base budget from 1 January 2020 (IPCC 2021a)	400 Gt CO_2		700 Gt CO_2	
Emissions for 2020, 2021, 2022 (Friedlingstein et al. 2022)	-121 Gt CO_2		-121 Gt CO_2	
Accounting for non-CO_2 greenhouse gases	Our best estimate -90 Gt CO_2 (Climate Council 2021b)	IPCC range ±220 Gt CO_2 (IPCC 2021a)	Our best estimate -90 Gt CO_2 (Climate Council 2021b)	IPCC range ±220 Gt CO_2 (IPCC 2021a)
Carbon cycle feedbacks	Our best estimate -97 Gt CO_2 Taking the upper end of IPCC's range, based on a precautionary approach to carbon cycle feedbacks.	IPCC range 26 ±97 Gt CO_2 39 Gt CO_2 (26 x 1.5) is already included in the base budget. (IPCC 2021a).	Our best estimate -97 Gt CO_2 Taking the upper end of IPCC's range, based on a precautionary approach to carbon cycle feedbacks.	IPCC range 26 ±97 Gt CO_2 44 Gt CO_2 (26 x 1.7) is already included in the base budget. (IPCC 2021a).
Remaining budget to net zero emissions	Our best estimate 92 Gt CO_2	IPCC range 280 ±317 Gt CO_2	Our best estimate 392 Gt CO_2	IPCC range 580 ±317 Gt CO_2
Date at which net zero emissions must be achieved globally, assuming linear rate of decline (based on our 'best estimate' figures above)	2027		2043	

DETERMINING A NET ZERO DATE FOR AUSTRALIA

As explored in Chapter 5, as a developed country with high emissions and significant opportunities for renewable energy and other climate solutions, we need to reduce emissions at a rate faster than the required global average, and achieve net zero emissions sooner than much of the rest of the world.

In 2014, the Climate Change Authority, using a modified version of a framework known as 'Contraction and Convergence',[7] concluded that to play its part in global emissions reduction efforts, Australia could use no more than 0.97 percent of the available global carbon budget. In Table 2, below, we show that by applying that factor to the global carbon budgets (in Table 1), Australia would need to achieve net zero emissions by 2038 to align with a global carbon budget that provides a 67 percent chance of limiting warming to 1.7°C, and 2027 for a 67 percent chance of limiting warming to 1.5°C.

Net zero by 2035 represents a point in this range (2027-2038) that balances the maximum rate of emissions reductions we believe is possible for Australia with the need to limit warming as much as possible and with the highest probability of success.

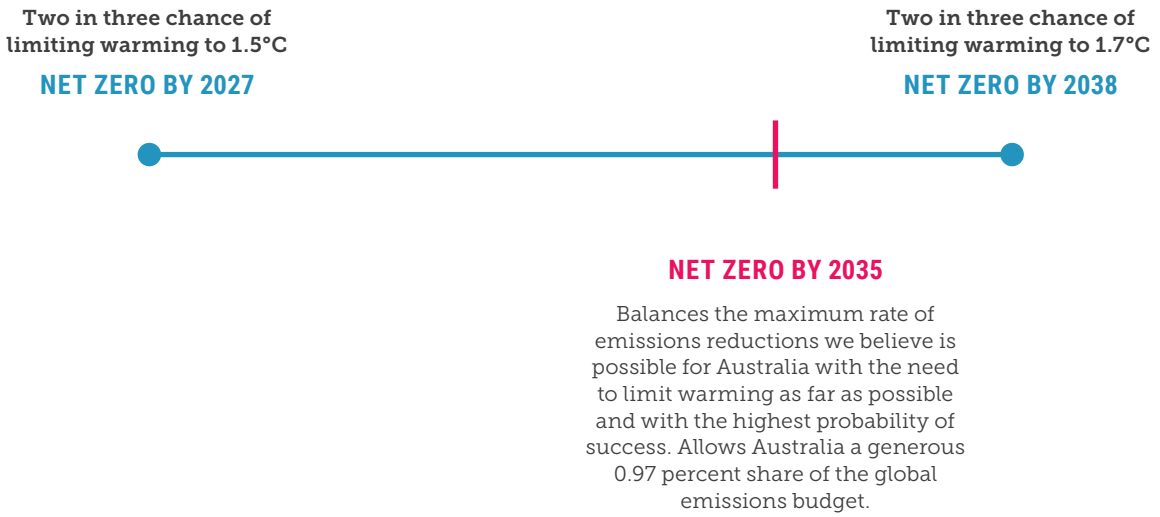
We must also recognize that we are being very generous to ourselves if we assume Australia is entitled to 0.97 percent of the global carbon budget, given we only account for 0.33 percent of the global population. If we were to base the calculations on every person being entitled to an equal share of the remaining global carbon budget, then Australia's share would be much smaller. Indeed, on such a measure we have effectively already exhausted our share of a budget that provides a 67 percent chance of limiting warming to 1.5°C.

All things considered, accepting the fundamental need to limit warming as much as possible, and given the role we should be playing in global efforts to tackle the climate crisis (see Chapter 5), Australia must aim to achieve net zero emissions no later than 2035.

7 Contraction and Convergence is one of the more popular frameworks proposed for determining a country's fair share of the global emissions budget. It starts from an assumption about the required global emissions reduction, and then applies the principle that every country should converge to the same level of emissions per person.

Table 2: Carbon budgets for Australia.

		Two in three chance (67 percent probability) of limiting warming to 1.5°C	Two in three chance (67 percent probability) of limiting warming to 1.7°C
Remaining budget to global net zero emissions		92 Gt CO_2	392 Gt CO_2
Australia's remaining budget to net zero emissions	0.97 percent share of the global budget	0.89 Gt CO_2	3.80 Gt CO_2
	Equal per capita (0.33 percent) share of the global budget	0.30 Gt CO_2	1.29 Gt CO_2
Date at which Australia should achieve net zero emissions, assuming linear rate of decline Emissions in 2022: 0.464 Gt CO_2 (DCCEEW 2023a)	0.97 percent	2027	2038
	Equal per capita (0.33 percent)	-budget exhausted-	2028



7. Conclusion

> *"We cannot afford to give in to despair. Better to channel our energy into action, as there's so much work to be done to prevent this crisis from escalating into a catastrophe. If the extremes of this summer fill you with fears of imminent and inevitable climate collapse, remember, it's not game over. It's game on."*
>
> - Professor Michael Mann and Susan Joy Hassol, 2023

Over the past two years, since we last published a report that set out the case for what Australia's climate targets should be, climate impacts have continued to escalate. More and more, we are living in an age of consequences for our past inaction, with communities in Australia and worldwide paying a heavy price. A price that is measured in the loss of lives and homes, in mental anguish, and in great uncertainty about our future (Chapter 2).

Having squandered opportunities to reduce emissions, and even added to the problem through reckless new fossil fuel developments, the path to avoiding climate catastrophe has narrowed (Chapter 6). However, as we draw perilously close to dangerous tipping points in our climate system, so too we are beginning to witness seismic economic and social shifts that propel us towards stronger action.

Globally, the cost of renewable energy has continued to plummet. In Australia, public support for stronger action on climate change reached an all-time high (The Australia Institute 2022). In 2022, Australians elected our most progressive Parliament on climate action. However, while we have seen sensible policy changes in the right direction we are yet to see the transformational leadership required to meet the scale of this crisis head on. Alarmingly, the expansion of the fossil fuel industry continues endangering all our futures (DISR 2022, Climate Council 2023h).

Our future depends on *far more* determined and deliberate action than we have seen to date.

Australia and the world are moving to cut harmful carbon emissions, but our future depends on *far more* determined and deliberate action than we have seen politically to date (Chapters 5 and 6). While it is important to acknowledge progress, we

need to move from slow and steady progress to lightning quick transformations across our economy.

The latest climate science, coupled with the lived experience of communities worldwide, is deeply confronting (Chapter 4). Yet, we must remember that the same science that so precisely predicted the rise in global temperatures that we are experiencing today also tells us that the future remains in our hands. Our actions today and through the 2020s will substantially shape the kind of world that young people alive today experience, and countless generations to come (Chapter 2).

For Australia to reduce emissions by 75 percent below 2005 levels by 2030 and reach net zero by 2035 we need more than targets: we need an action plan that spells out how it will be done. Governments must lead and drive those plans and we must all pull together to deliver them: governments, businesses, civil society, communities and individuals.

There are practical steps governments can and should be taking right now to start cutting emissions at this speed and scale. The Australian Government should fix our national environment law so that it no longer gives the green light to polluting fossil fuel projects, put in place strong fuel efficiency standards to slash pollution from our cars, and turbocharge the electrification of our grid. State, territory and local governments should speed up the electrification of homes, businesses and transport, while reshaping how our cities are designed so liveability and sustainability comes first.

These and other actions will unlock the huge private investment needed so industry can start driving solutions to the climate crisis, instead of being part of the problem. Clean energy, green industries and new technologies can form the backbone of our future economy - so Australia can help the world cut emissions while getting paid for it.

Figure 16: The actions we must take to drive down emissions and tackle the climate crisis are also a path to a fairer, healthier and happier society.

All this can get Australia on track to meet and then improve on the existing and inadequate target of reducing emissions by at least 43 percent below 2005 levels by 2030. These actions are important steps towards creating not only a cleaner economy, but also a fairer, healthier and happier society.

We cannot cut Australia's emissions at the speed and scale now needed if we do not phase out fossil fuels; both their use in our energy system at home as well as exports. That starts with ending the approval of new and expanded coal, oil and gas projects - *any* new fossil fuels add more fuel to the already-raging fire of climate change. By 2035, Australia will need to have fully replaced fossil fuels with solar, wind and other renewable sources backed by storage for our own energy, transport and industrial needs. As well as developing new, clean export industries to meet the needs of our international partners.

In setting any future target for 2035, the Australian Government should set out how we get from where we are today - as a fossil fuel heavyweight - to the clean and prosperous future that is ours for the taking.

Decades of inaction mean we are now minutes to midnight. The task ahead is immense. Every squandered opportunity today adds to the dangers and hardships for future Australians, and communities worldwide. Conversely, every positive action that helps reduce emissions will be measured in a safer, healthier and happier future for us all.

We must aim higher and go faster.

SUMMARY OF POLICY RECOMMENDATIONS

Climate Council recommends that Australia's emissions reduction targets and our next Nationally Determined Contribution to the *Paris Agreement*:

- Be based on genuine emissions reductions. The use of offsets must be minimised and accounted for separately, in order that we are measuring and transparently accounting for real and effective efforts to limit climate damage. (Page 24.)
- Aim to limit warming as far as possible and with the highest probability of success. This means aligning as close as possible with a budget that provides a 67 percent chance of limiting warming to 1.5°C. (Page 31.)
- Recognise the extreme and existential risks posed by tipping points in the climate system, and the need to do everything possible to eliminate the risk of catastrophic scenarios. (Page 40.)
- Represent a fair share of the global emissions reduction task, factoring in Australia's historical responsibility for climate change, our economic capability, and our natural advantages in renewable energy. (Page 45.)

We assess that Australia's 2035 target must be net zero.

Appendix: Carbon budget methodology

CARBON CYCLE FEEDBACKS

The starting point for our updated calculations (Table 1, page 47) is the global carbon budgets provided in the Working Group I Contribution to the IPCC's Sixth Assessment Report (IPCC 2021a).[8] Carbon budget estimates are subject to a large degree of uncertainty, particularly when it comes to 'carbon cycle feedbacks' and reductions in non-CO_2 greenhouse gases.

Carbon cycle feedbacks are processes within the carbon cycle that either amplify or dampen the effects of climate change. These are known as positive and negative feedbacks respectively. A key example of a positive carbon cycle feedback is the thawing of carbon-rich permafrost. As global temperatures rise, permafrost – that is, permanently frozen land in the high latitudes and some other areas including the Tibetan Plateau – begins to thaw. As it thaws, carbon is released into the atmosphere in the form of CO_2 and methane - both greenhouse gases. This leads to further warming, which leads to more thawing, and so on.

While we know these feedbacks exist, we can only estimate what their overall effect will be. In its latest assessment, the IPCC provides a best estimate that, to account for permafrost thaw and a number of other carbon cycle feedbacks, the global carbon budget should be reduced by 26 Gt CO_2 per degree of warming (IPCC 2021a). Therefore, for example, the IPCC's budget for a 67 percent probability of limiting warming to 1.5°C (400 Gt CO_2) factors in a reduction of 39 Gt CO_2 (26 x 1.5°C) to account for the effect of carbon cycle feedbacks and to arrive at a final budget estimate. However, the best estimate of 26 Gt CO_2 per degree of warming includes a wide range of uncertainty: $\pm$ 97 GtCO_2. In other words, the effect of carbon cycle feedbacks could be considerably greater, leading to much worse and potentially catastrophic outcomes. As discussed in Chapter 4, when dealing with something as serious and far-reaching as the climate crisis, prudent risk management demands that we work to reduce the probability of the worst-case scenarios as much as possible. Therefore, for our own estimates of global carbon budgets, we have taken a more precautionary approach and reduced budgets by a further 97 Gt CO_2, reflecting the upper end of the IPCC's uncertainty range.

8 Our 2021 report *Aim High, Go Fast* (Climate Council 2021b) based its calculations on the global carbon budgets published in the IPCC's Special report on Global Warming of 1.5°C (2018), taking account of additional research into carbon cycle feedbacks. Coming a little later in the IPCC's Sixth Assessment cycle, and after the publication of our 2021 report, the Working Group I Contribution to the IPCC's Sixth Assessment Report (2021) re-assessed a number of factors that determine estimates of global carbon budgets. While the change between the estimates in these two reports was small, we have updated our calculations so that they are based on the latter report and thereby the latest IPCC advice. (Working Group I of the IPCC focuses on the physical science of climate change.)

NON-CO_2 GASES AND AEROSOLS

A second area of uncertainty in global carbon budgets, and where we again argue that a more precautionary approach is warranted, relates both to the rate at which we manage to reduce non-CO_2 greenhouse gases including methane, as well as to reductions in emissions of aerosols[9] as we stop burning fossil fuels. In its latest assessment, the IPCC provided a wide range of uncertainty for the effect of reductions of non-CO_2 emissions: $\pm$ 220 Gt CO_2. For this report and our own updated calculations, we are using an estimate of 90 Gt CO_2, the same as we used in our 2021 report *Aim High, Go Fast* (Climate Council 2021b). This is based on recent trends in emissions of methane, nitrous oxide and aerosols, all of which suggest that estimates of global carbon budgets need to be reduced further.[10]

LESS ROOM TO MOVE

With each year of emissions, we are using more of the global carbon budget. When the IPCC published its Special Report on Global Warming of 1.5°C in 2018, the headline finding echoed around the world: we must roughly halve global greenhouse gas emissions within 12 years (45 percent below 2005 levels by 2030) for a reasonable chance at limiting warming to 1.5°C (IPCC 2018). Nearly half way through that critical window, and Australia and the world's emissions have remained stubbornly high.

Globally, bar a temporary fall during the Covid-19 pandemic, emissions have continued to rise (Friedlingstein et al. 2022). In Australia, while we are now seeing a welcome and long overdue decline in emissions from electricity as ageing coal-fired power stations are replaced by renewable energy, this progress has been partly cancelled out by rising emissions in other sectors including transport and agriculture (DCCEEW 2023a).

When excluding emissions reductions attributable to carbon being stored in the land and forests, Australia's total emissions have fallen a mere 0.2 percent since 2005 (DCCEEW 2023a, 2023b).[11]

The latest IPCC assessment provides global carbon budgets from 2020 (IPCC 2021a). For our calculations, we have updated these budgets to reflect the amount of emissions produced since 2020, and thereby the amount remaining in the budget, using data from the Global Carbon Project (Friedlingstein et al. 2022).

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9 Aerosols are tiny solid particles or liquid droplets suspended in the atmosphere. These have both natural origins, such as from volcanic eruptions, as well as human causes, including particulate pollution from the burning of fossil fuels.

10 In our 2021 report *Aim High, Go Fast*, we provided the following rationale for a reduction in global carbon budgets of 90Gt CO_2 to account for non-CO_2 gases and for aerosols:

1. Emissions of both methane (CH_4) and nitrous oxide (N_2O) are rising, with the rate of CH_4 emissions increasing over the past decade after a period of very little or no growth (International Energy Agency 2023) and emissions of N_2O increasing at a rate of about 2 percent per decade (Tian et al. 2020).
2. A significant fraction of both CH_4 and N_2O emissions come from the agriculture sector, and are considered more difficult to reduce than CO_2 emissions.
3. Global aerosol emissions could decrease in future, as they have in China over the past decade or so, as countries take measures to reduce local air pollution.

The net effect of these assumptions is that the CO_2 budget will need to be reduced further to compensate for both of these effects.

11 Based on data from the National Greenhouse Gas Inventory up to 2022. For 2005-2021, data was taken from the Paris Agreement inventory within the National Greenhouse Gas Inventory. This was supplemented with data for 2022 from the December 2022 Quarterly Update of the National Greenhouse Gas Inventory. When accounting for Land Use, Land Use Change and Forestry (LULUCF), Australia's emissions have fallen by around 25 percent since 2005. LULUCF refers to the amount of carbon being stored or released from land-based ecosystems, including from forests and soils, as a result of human activities. For example, if an area of land that had been cleared for agriculture is reforested, then the emissions absorbed can be counted as part of Australia's net emissions. Notwithstanding the importance of ending forest clearing and restoring ecosystems, given the qualitative differences between a tonne of carbon emitted through the burning of fossil fuels and a tonne absorbed by land-based ecosystems (see Chapter 3), we feel it is important here to highlight the change (or lack thereof) in Australia's emissions exclusive of LULUCF.

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Need support for your mental health?

HERE ARE SOME ORGANISATIONS AND RESOURCES

General information

Psychology for a Safe Climate
www.psychologyforasafeclimate.org

For advice on looking after your mental health following a disaster

Natural Disasters and Your Mental Health (Beyond Blue)
www.beyondblue.org.au/mental-health/natural-disasters-and-your-mental-health

For children and young people

I'm Worried About the Environment (Kids Helpline)
kidshelpline.com.au/teens/issues/worried-about-environment

Understanding Anxiety About Climate Change (Headspace)
headspace.org.au/explore-topics/for-young-people/understanding-anxiety-about-climate-change

The Climate Council is an independent, crowd-funded organisation providing quality information on climate change to the Australian public.

The Climate Council acknowledges the Traditional Owners of the lands on which we live, meet and work. We wish to pay our respects to Elders past and present, and recognise the continuous connection of Aboriginal and Torres Strait Islander peoples to Country.

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