CLIMATE COUNCIL

WELCOME TO QUEENSLAND: RENEWABLE ONE DAY, AND THE NEXT, AND NEXT...

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Welcome to Queensland: Renewable one day, and the next, and next ...

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Cover image: 'Woman working at the Kidston solar farm.' Image courtesy of Genex Power.

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Key Findings

1

Queenslanders are on the frontline of climate change and extreme weather impacts.

- Queensland is highly exposed to extreme weather, and has borne 60% of the total economic costs of extreme weather in Australia in the decade from 2007 to 2016.
- Climate change is increasing the intensity of extreme weather events that affect Queenslanders – drought, bushfires, heatwaves, floods and cyclones. These events are taking a heavy toll on the health of Queenslanders, and on the state's many natural assets.
- Currently 65% of Queensland is drought declared, with significant impacts on the state's rural sector. Parts of the state's west and south have been drought-affected for more than six years.
- More than 80% of damages resulting from rising sea levels and storm surges in Australia are projected to occur in Queensland. The most vulnerable area, the Gold Coast, accounts for almost a quarter of projected national damages from sea-level rise alone.
- Queensland's economy is reliant on climate-sensitive industries such as tourism and agriculture, and therefore needs strong local, national and international climate change action to reduce its vulnerability.

2

Queenslanders are embracing solar energy in record numbers and the state will benefit more than most from transitioning to renewable energy.

- Queensland is called the sunshine state for a reason. One third of all households have rooftop solar, which can significantly reduce power bills. The state also has the most large-scale solar projects under construction of any state or territory.
- Renewable energy projects under construction or about to begin will create more than 4,500 jobs and deliver almost $10 billion in investment to Queensland. This is in addition to the 5,080 current jobs in the sector, which is more renewable jobs than in any other state or territory.
- North and central Queensland will be a major beneficiary of the transition to renewable energy, with the region home to six of the ten renewable energy projects under construction in the state. Already solar is affordably and reliably supplying one-third of the electricity needs of Townsville's Sun Metals zinc refinery, supporting 450 new local jobs.
- Jobs in thermal coal are subject to uncertainty and insecurity as the world moves rapidly towards renewables plus storage (e.g. from batteries). A plan needs to be developed between stakeholders such as communities, government, industry and unions that ensures coal mine workers are supported to find fulfilling and rewarding jobs in other industries, including retraining where necessary.

3

Queensland has a pivotal role to play in the global climate effort by driving a smooth and just transition to net zero emissions. It is clear that the burning of fossil fuels - coal, oil and gas - must be phased out rapidly to avoid the worst impacts of climate change.

- Australia has signed the Paris Agreement to keep global temperatures well below 2°C.
- Mining and burning the thermal coal in the Galilee Basin and other such deposits around the world would make the Paris target impossible to achieve.
- 2°C warming would sign the death warrant of the Great Barrier Reef, a multi-billion-dollar asset supporting 64,000 Australian jobs.
- To limit warming to well-below 2°C, a rapid phase-out of all fossil fuels is required by 2050 at the latest. This means that the vast majority of fossil fuel resources must remain in the ground unburned, and that no new fossil fuel facilities, or extensions or upgrades to existing facilities, should be permitted.

1. Introduction

Queensland is rich in energy resources of the past and future: the historically important thermal coal and gas, as well as the more recent surge in solar and wind energy, which now dominate global energy investment. As the world increasingly shifts away from fossil fuels to a renewable energy future, Queensland can position itself as a leader in the transition to a modern, clean renewable powered economy.

Queensland is also on the frontline of climate change impacts. Climate change, largely driven by the burning of thermal coal, oil and gas, is worsening extreme weather events that threaten Queensland's unique natural assets, as well as its climate-sensitive major industries such as tourism and agriculture. Tourism employed about 138,000 people in Queensland in 2016-17 (Tourism and Events Queensland 2018) and agriculture employed an average of 69,600 people in the year to May 2019 (ABS 2019a). Together, tourism and agriculture employ over 207,000 Queenslanders, eight times the number of Queenslanders employed in coal mining (Queensland Treasury 2018; ABS 2019a).

Queenslanders want action on climate change to protect livelihoods and the iconic natural assets of Queensland. About 24% of Queenslanders rated the environment as their top issue in the recent federal election, similar to the nation-wide average of 29% (ABC 2019a).

Queensland is already leading Australia in many aspects of renewable energy. However, more needs to be done to unlock the enormous renewable potential and associated growth in jobs and economic opportunities.

This report first outlines the key climate change risks to Queensland. The report then shows how – given its plentiful renewable energy resources – Queensland stands to benefit more than other states and territories from leading the transition to renewable energy. Finally, the report highlights the significant influence of Queensland's decisions on global efforts to tackle climate change.

The tourism and agriculture sectors in Queensland employ 207,000 people, eight times the number of Queenslanders employed by the coal industry.

Figure 1: Queensland's tourism industry is a substantial employer, providing about 138,000 direct jobs in 2016-17.

2. Queensland is on the Frontline of Climate Change

Queensland is on the frontline of climate change impacts in Australia, which is itself one of the most vulnerable to climate change of any developed countries in the world. Queensland's vulnerability arises from its greater exposure to hazards, including those that are influenced by climate change, and its economic dependence on climate-sensitive industries, such as agriculture and tourism.

Climate change is driving an increase in the frequency and/or severity of extreme weather events in Queensland including heatwaves, intense rainfall, coastal flooding and severe bushfires. Queensland is particularly exposed to such hazards and incurred a total economic cost of $11 billion per year in the decade from 2007 to 2016 – 60% of the national cost during this period (Deloitte 2017a). These costs include direct costs from immediate damages, and indirect costs over the medium and longer terms, including costs associated with disruptions to business continuity and increased costs of health and social services.

About 44% of Queensland's population is exposed to high or extreme risk of flooding and 86% of the population is exposed to high or extreme risk of tropical cyclones (Deloitte 2017a). In fact, the vast majority of damages from extreme weather events in Queensland come from the impacts of floods and cyclones (Deloitte 2017a).

Queensland shouldered 60% of the costs of extreme weather in Australia over the decade from 2007 to 2016.

COMPOUND HAZARDS: THE SUMMER OF 2018/2019

The potential damages from hazards are much greater when hazards strike simultaneously or in close sequence. Climate change is contributing to an increase in these so called 'compound events', as return periods between events shorten. For example, during the summer of 2018/19 Queensland experienced a series of consecutive and coincident extreme weather events (several of which were record-breaking), including drought, heatwaves, bushfires, floods and cyclones - costing the Queensland Government and taxpayers $1.5 billion (ABC 2019b).

Towards the end of November 2018, a broad area heatwave affected the north tropical and central coasts of Queensland. During the heatwave, many locations experienced their highest daily maximum temperature on record, for November or for any month. Extreme heatwave conditions extended from the Lockhart River to Shoalwater Bay on the Capricornia Coast and adjacent inland areas. During the heatwave, numerous locations on the north tropical coast recorded temperatures above 40°C, with Townsville (Mt Stuart) recording the highest temperature of 45.2°C on the 26th. Rockhampton recorded a daily maximum temperature of 44.4°C and Yeppoon reached 42.2°C (BoM 2018).

The heatwave, combined with the very dry conditions due to the ongoing drought, and strong winds, led to the materialisation of fire behaviour that had never before been seen in the state at a similar scale. In the Rockhampton area, the Bureau of Meteorology's Forest Fire Danger Index reached 130 for the first time on record. Readings above 100 on the FFDI are considered to be catastrophic, meaning that "fires will burn so fast and hot that control is virtually impossible" (CSIRO 2018). Hundreds of fires were started or flared during the heatwave event, and by December 6 about one million hectares of bushland, farmland and rainforest had been destroyed. This is the largest area of land affected by bushfires in Queensland since record-keeping began. An estimated 800 residents were evacuated in Deepwater, as were 4,000 residents in Gracemere. Damage assessments recorded that nine dwellings were destroyed and eight damaged alongside numerous other sheds and structures. Damage was also recorded to horticulture plantings, livestock and crops.

Just days later Tropical Cyclone Owen approached the north Queensland coast, dumping record-breaking rainfall on the Hinchinbrook Shire, just north of Townsville, resulting in extensive flooding and raising concerns about potential landslides on areas that had been devastated by the recent bushfires. A few weeks later, a monsoonal trough brought record-breaking 7-day and 10-day accumulated rainfall to Townsville and surrounds (BoM 2019a).

During the 2018/19 summer Queensland was affected by a series of record-breaking extreme weather events including drought, heatwaves, bushfires and floods.

The subsequent flooding killed three people and affected thousands of properties. Final damage assessments conducted by Queensland Fire and Emergency Services have revealed that 2,063 properties experienced floodwater inundation of up to 25 cm, 1,101 properties experienced inundation of up to 1 metre and 135 properties suffered inundation of over 1 metre (Townsville Bulletin 2019). The floods in north Queensland also killed an estimated 664,000 cattle worth $800 million (ABC 2019c).

Almost overnight parts of Queensland transitioned from drought to flood disaster zones, but this did not diminish the drought gripping large inland parts of the state. Currently, 65% of Queensland is still drought declared (Queensland Government 2019a).

HEATWAVES AND MARINE HEATWAVES

Annual temperatures in Queensland have been rising strongly since around the 1980s, with nine out of the ten hottest years on record occurring since 2002 (BoM 2019b). The climate has shifted to a hotter state, influencing maximum, mean and minimum temperatures. Extreme heat has been experienced in the past during historical droughts, and during El Niño periods (e.g. 1915, 1942 and 1988). However, there has been a very marked increase in extreme heat in Queensland over recent decades. For example, annual maximum temperatures that are within the hottest 10% of observed temperatures over large parts of Queensland's land mass have increased in recent decades (see Figure 3a).

The top 10% of annual minimum temperatures have also increased over large parts of Queensland in recent decades (see Figure 3b). Figure 3b shows a very clear trend post-1970 of increasing annual minimum temperatures over large areas of Queensland – a trend that is clearly correlated with the rising average global temperature due to climate change.

Whilst Australia has always experienced cyclical droughts and heatwaves, human influences on the climate since the mid-late 20th century are now influencing Queensland's natural temperature variability, and have shifted the climate into a hotter state on average. At the same time, climate change is also expected to influence major drivers of natural climate variability, including the El Niño–Southern Oscillation (ENSO). For instance, warming of just 1.5°C is expected to double the frequency of extreme El Niño events (Wang et al. 2017).

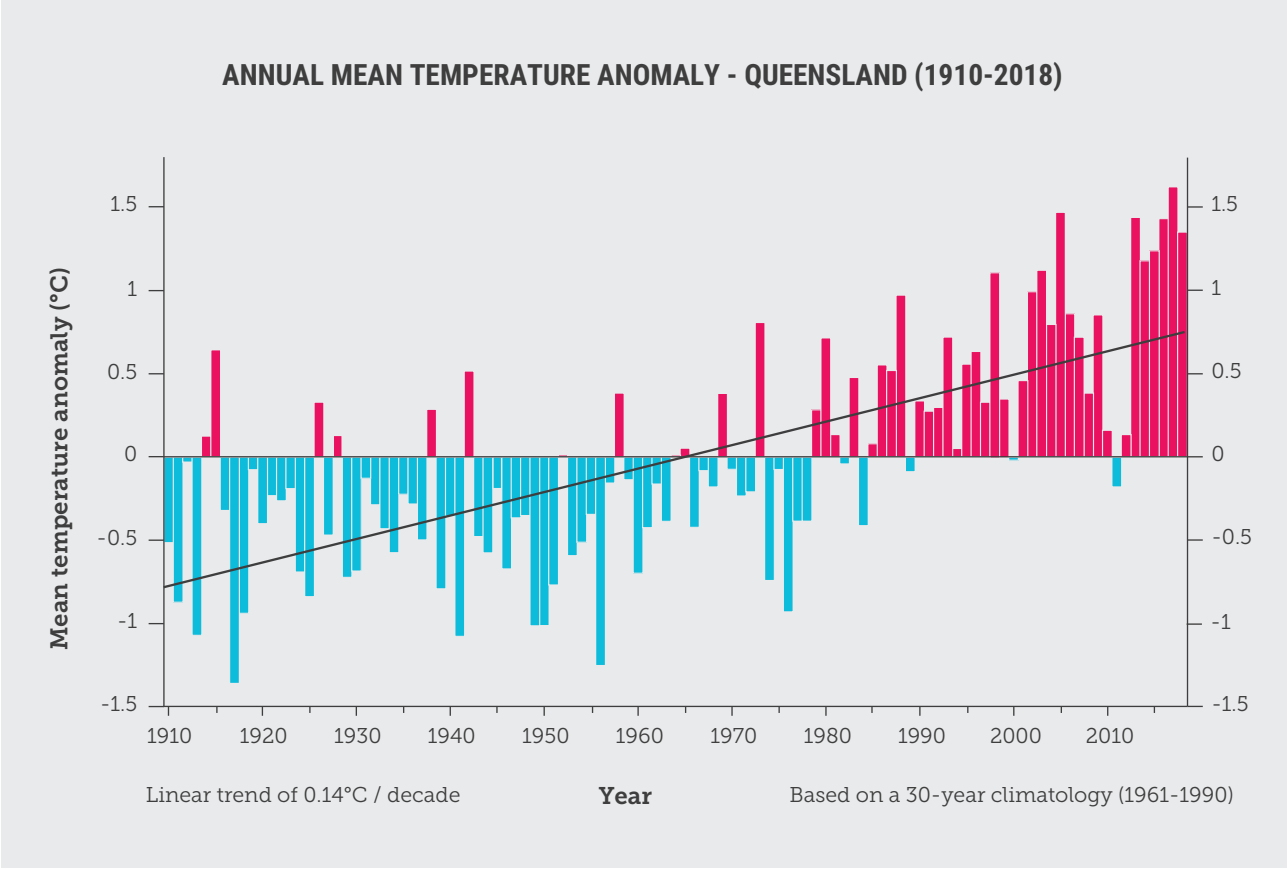
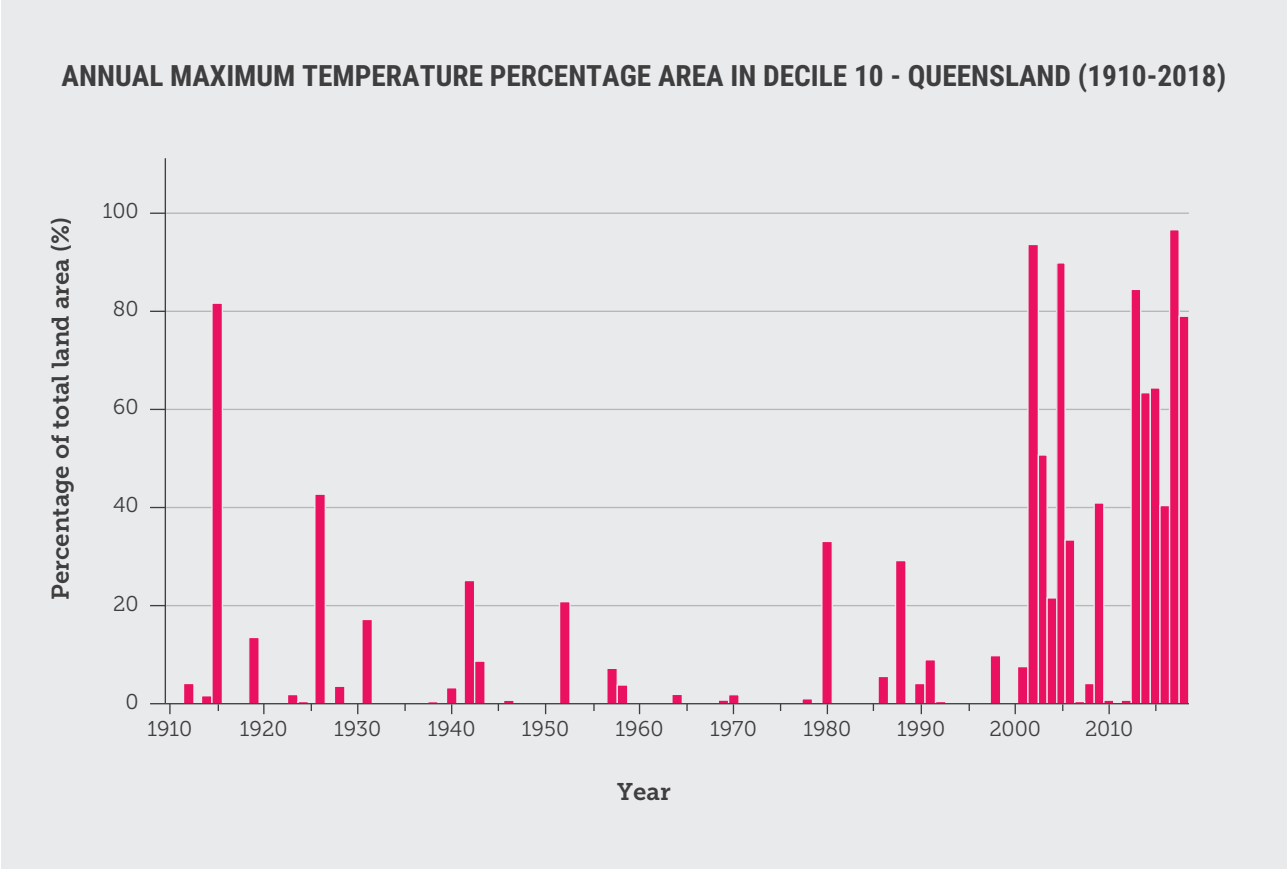


Figure 2: Queensland's mean temperature has been rising steadily. **Source:** BoM (2019b).



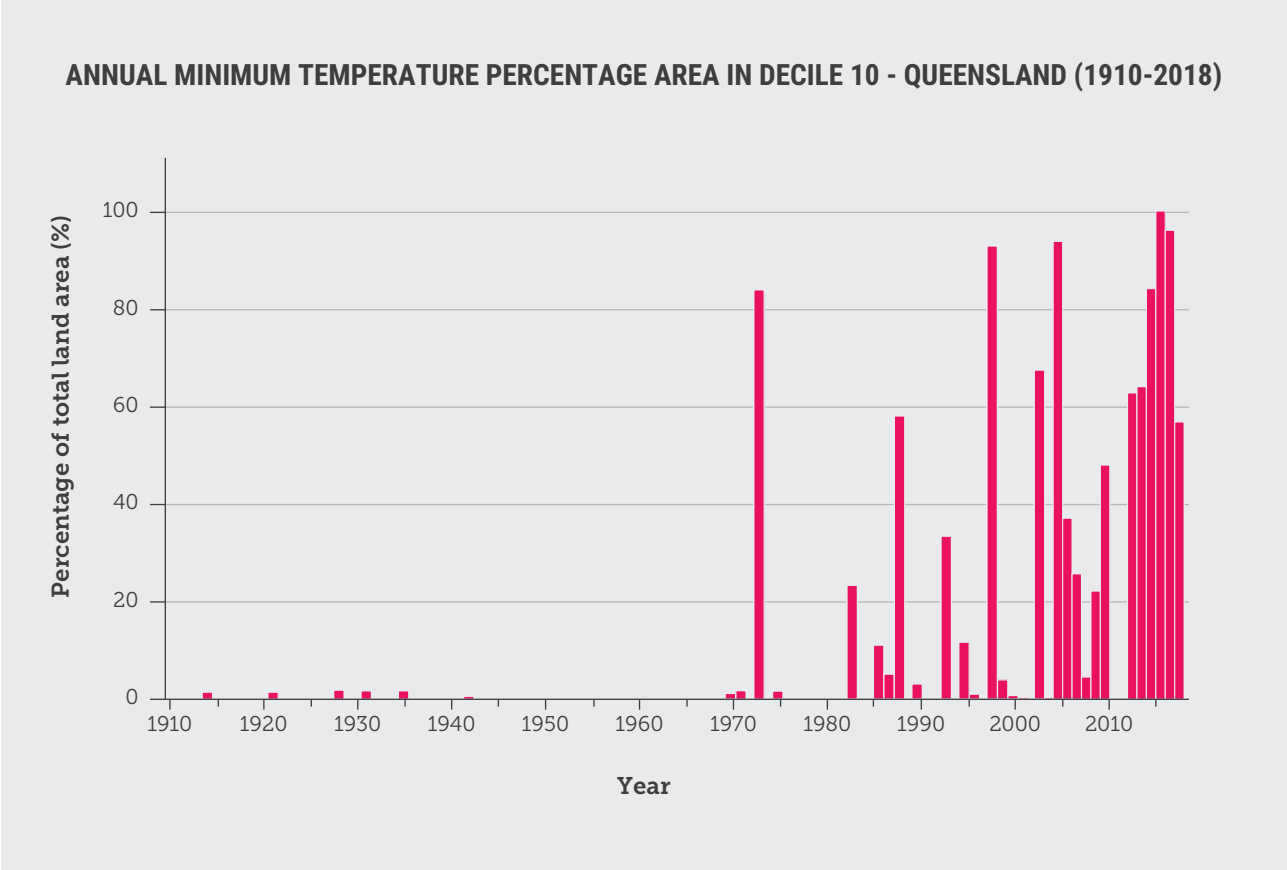


Figure 3: The spatial extent affected by the highest 10% of annual maximum (a) and annual minimum (b) temperature observations has increased markedly over recent decades. **Source:** BoM (2019b).

Climate change has also driven an increase in heatwave characteristics over the past 70 years, particularly in southwest and central Queensland. By 2090, Queensland could experience 15% of the year in heatwave conditions, up from 3% of the year in 2018 (QFES 2019). The average duration of heatwaves could increase from four days to 30 days, and the average temperature of all heatwaves could increase from 32.5°C to 36°C, an increase of 3.5°C. The average temperature of the hottest heatwaves could increase by 9°C (QFES 2019). Future projections for heatwave characteristics in selected locations across Queensland are shown in Figure 4 below. These changes to heatwave characteristics would have major consequences, including increased mortality especially amongst older people and people with pre-existing health conditions, increased pressure on hospitals and emergency services, reduced labour productivity, damage and disruption to infrastructure such as transport and electricity, detrimental impacts on ecosystems and adverse effects on crops and livestock (QFES 2019).

If emissions continue on a business-as-usual trajectory, in the Gold Coast days over 35°C would rise from a historical average of one day per year, to 34 days per year in 2090. In Brisbane, days over 35°C would rise from a historical average of two days to 45 days by 2090. In Rockhampton, days over 35°C would increase from a historical average of 14 days per year to 121 days by 2090, and in Townsville, days over 35°C would increase from a historical average of 3 days per year to 108 days per year. As this would be concentrated in summer, it could mean that almost every summer day is over 35°C in Townsville by 2090 (TAI 2019).

In 2016 and 2017 marine heatwaves on the Great Barrier Reef led to unprecedented, back-to-back mass bleaching events that ultimately led to the mortality of around one third of the corals on the Great Barrier Reef (Hughes et al. 2018). The Reef is the largest living structure on Earth. It spans 2,300 kilometres and provides habitat for hundreds of thousands of marine and coral species.

Climate change is widely recognised to be the single biggest threat to the Great Barrier Reef. As noted by the Intergovernmental Panel on Climate Change (IPCC) 1.5°C report, coral reefs are projected to decline by a further 70–90% even if the global average temperature rise is limited to 1.5°C above pre-industrial levels, with larger losses (>99%) at 2°C. The risk of irreversible loss of many marine and coastal ecosystems increases with global warming, especially at 2°C or more (IPCC 2018).

Although the Great Barrier Reef is arguably priceless, there are some quantifiable aspects of its value. It supports 64,000 jobs (39,000 of which are direct jobs) and contributes $6.4 billion to the Australian economy. Within Queensland alone, the Great Barrier Reef generates revenue of $3.9 billion and provides 33,000 jobs (Deloitte 2017b). By contrast, coal mining provides around 25,000 jobs in Queensland, or 1.2% of jobs (ABS 2016).

The Great Barrier Reef supports 33,000 jobs in Queensland and contributes $3.9 billion to Queensland's economy each year.

HEATWAVE PROJECTIONS FOR SELECTED LOCATIONS IN QUEENSLAND (1986 TO 2090)

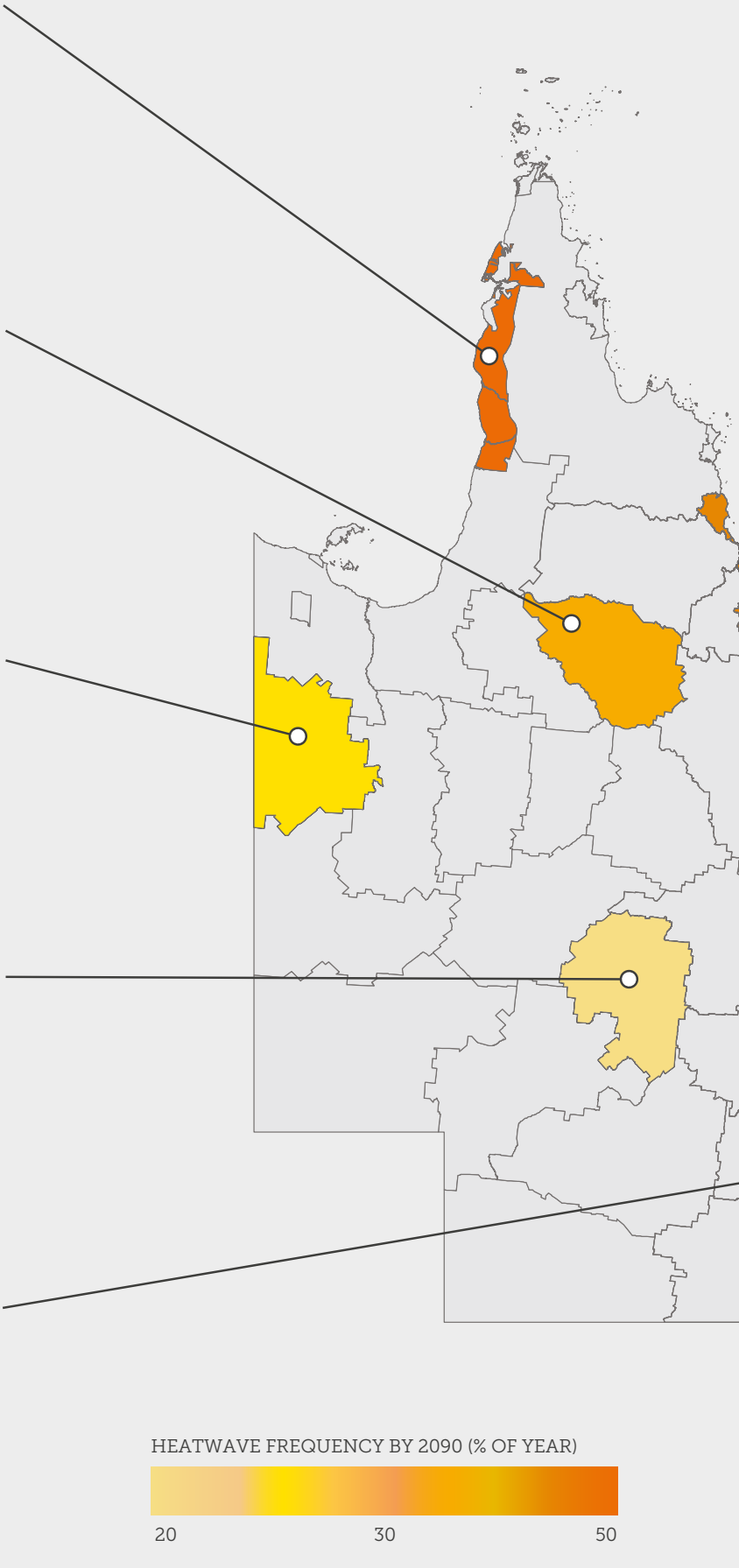
EASTERN GULF OF CARPENTARIA				
Heatwave Index	Reference	2030	2050	2090
Heatwave Frequency (%)	0.4%	3.5%	8.8%	44.4%
Heatwave Duration (days)	2	6	14	62
Days >35°C	65	81	99	189
Nights >20°C	253	288	320	358

ETHERIDGE				
Heatwave Index	Reference	2030	2050	2090
Heatwave Frequency (%)	1.7%	2.9%	8.2%	33.0%
Heatwave Duration (days)	2	4	9	48
Days >35°C	91	112	152	213
Nights >20°C	159	192	224	295

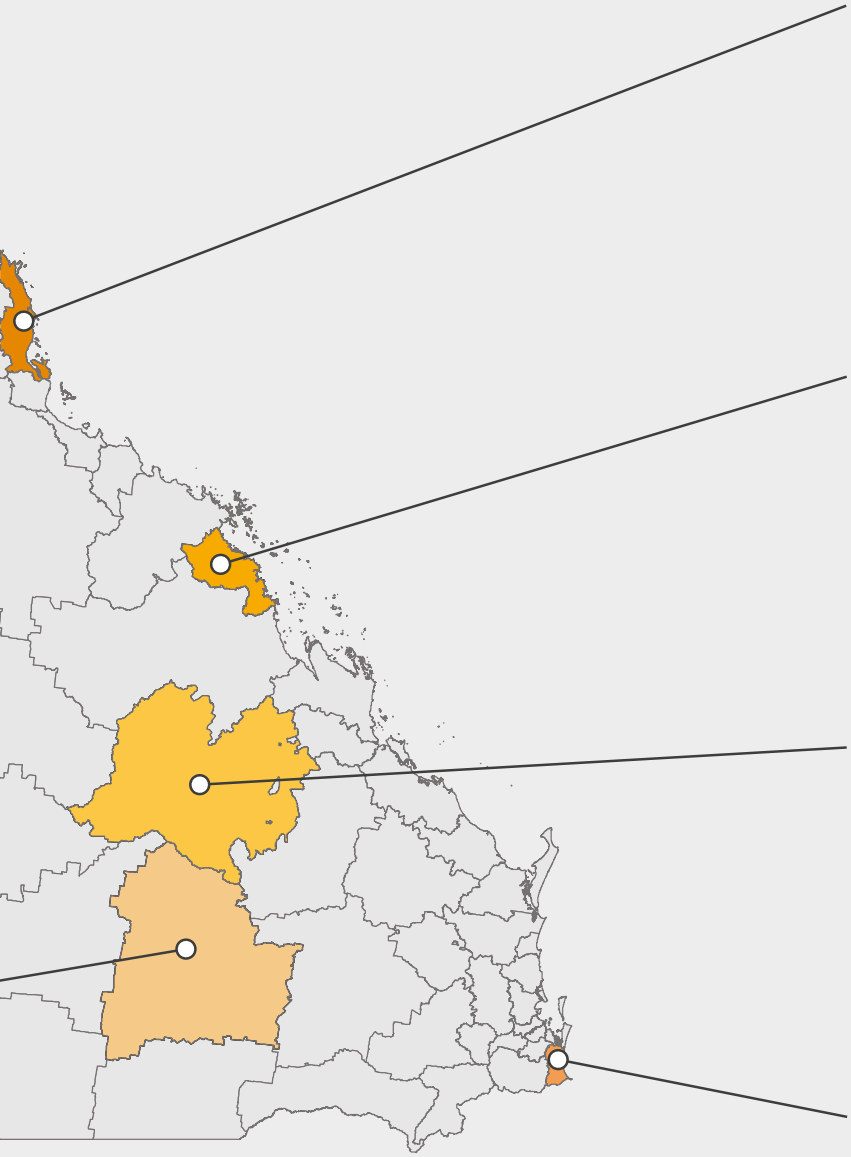
MOUNT ISA				
Heatwave Index	Reference	2030	2050	2090
Heatwave Frequency (%)	1.6%	3.1%	7.2%	22.8%
Heatwave Duration (days)	4	3	7	29
Days >35°C	148	168	203	267
Nights >20°C	177	203	226	284

LONGREACH				
Heatwave Index	Reference	2030	2050	2090
Heatwave Frequency (%)	2.3%	3.3%	8.1%	21.5%
Heatwave Duration (days)	5	3	8	26
Days >35°C	123	145	171	217
Nights >20°C	133	163	189	240

MARANOA				
Heatwave Index	Reference	2030	2050	2090
Heatwave Frequency (%)	2.5%	2.8%	7.6%	22.3%
Heatwave Duration (days)	5	3	7	23
Days >35°C	46	54	76	98
Nights >20°C	60	93	122	182



UNDERSTANDING THE DATA	
Heatwave Index	Definition
Heatwave Frequency (%)	Number of heatwave days relative to number of days in a year - i.e. [number of heatwave days/365] x 100 (%)
Heatwave Duration (days)	Number of days of the longest heatwave of the year (days)
Days >35°C	Annual count of days with maximum temperature >35°C
Nights >20°C	Annual count of nights with minimum temperature >20°C
Note: All figures represent an absolute change from the reference period (1986 to 2005) unless expressed in negative terms, based on RCP 8.5.	



WET TROPICS COAST

Heatwave Index	Reference	2030	2050	2090
Heatwave Frequency (%)	1.4%	3.1%	12.5%	41.6%
Heatwave Duration (days)	3	4	15	80
Days >35°C	3	4	17	72
Nights >20°C	179	217	253	321

MACKAY

Heatwave Index	Reference	2030	2050	2090
Heatwave Frequency (%)	2.1%	3.2%	10.6%	35.8%
Heatwave Duration (days)	4	4	11	72
Days >35°C	4	9	20	67
Nights >20°C	128	157	186	255

CENTRAL HIGHLANDS

Heatwave Index	Reference	2030	2050	2090
Heatwave Frequency (%)	2.7%	3.0%	8.1%	26.5%
Heatwave Duration (days)	5	3	7	33
Days >35°C	50	62	85	117
Nights >20°C	86	117	146	206

CITY OF GOLD COAST

Heatwave Index	Reference	2030	2050	2090
Heatwave Frequency (%)	2.1%	3.1%	8.9%	28.4%
Heatwave Duration (days)	4	4	9	45
Days >35°C	1	3	6	34
Nights >20°C	50	76	106	175

Figure 4: Heatwave projections for selected locations in Queensland. Infographic created by Queensland Fire and Emergency Services (QFES 2019). Data supplied by the Climate Science Division, Department of Environment and Science.

SHIFTING RAINFALL PATTERNS, DROUGHTS AND FLOODS

The range of natural variability in rainfall is very large in Queensland, primarily as a result of the El Niño–Southern Oscillation (ENSO), which also influences monsoon activity experienced during the northern 'wet season'. ENSO is the dominant influence on year-to-year rainfall that drives drought and flood conditions in the region. As seen in Figures 5 and 6, Queensland is the state most heavily influenced by rainfall extremes associated with ENSO. There is increasing observational evidence to suggest that ENSO activity has increased since the 1950s, with a high number of extreme El Niño events recorded since the 1970s (e.g. 1982-83, 1997-98 and 2015-16) (Gergis and Fowler 2009; McGregor et al. 2013; Santoso et al. 2017). Climate modelling studies indicate a continued increase in the frequency of extreme El Niño events due to global warming (e.g. Cai et al. 2014; Wang et al. 2017), meaning regions like Queensland are very likely to experience more frequent weather-related disasters in the future.

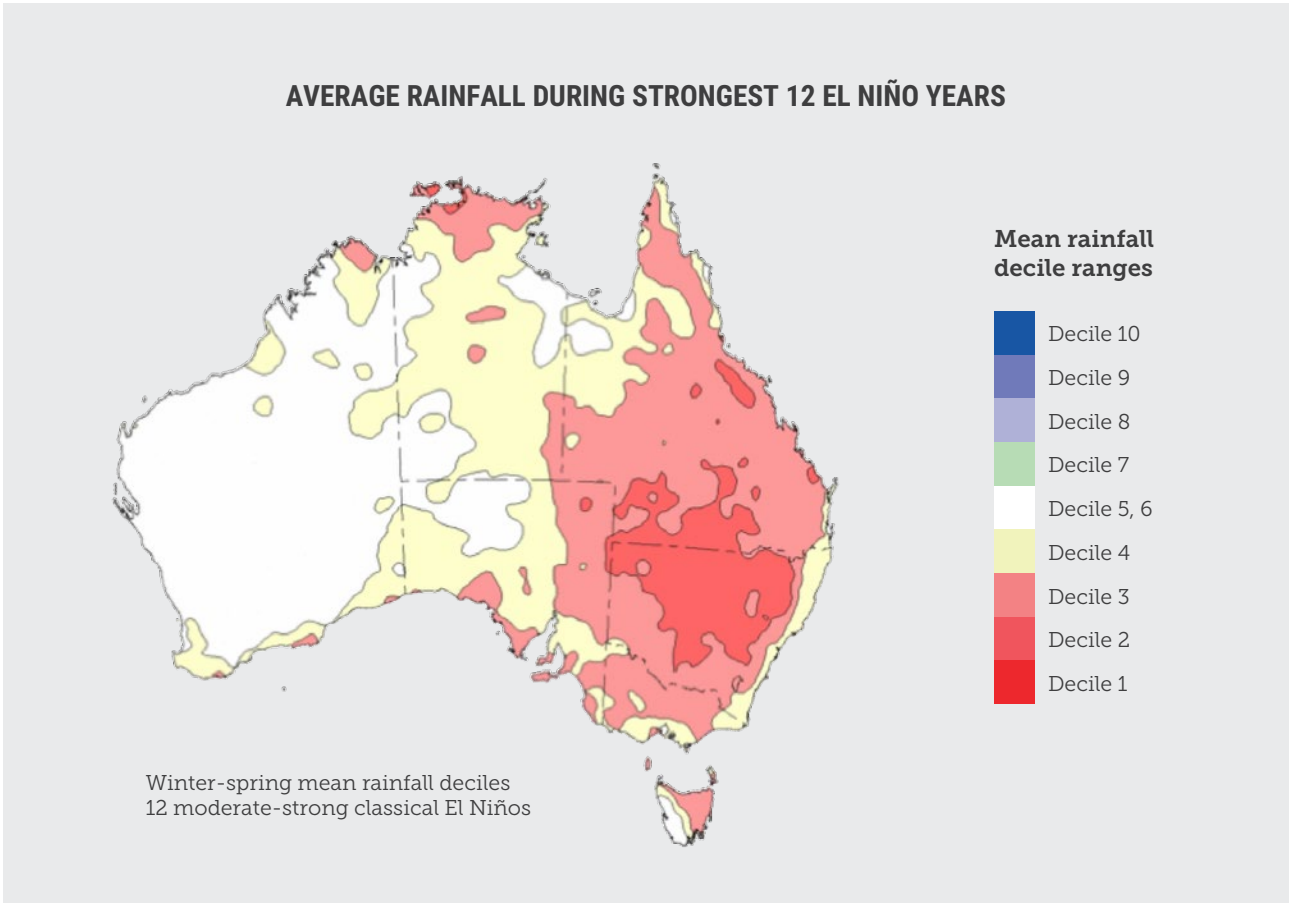


Figure 5: Average rainfall during strongest 12 El Niño years. **Source:** BoM (2019c).

Although there is a lot of rainfall variability across different parts of Queensland, some important trends have been discerned over recent decades. Rainfall has been very low over parts of southern Australia during the cool season (April-October) over the past 20 years (see Figure 7). This has affected parts of southern and central Queensland, including areas that derive more than 40% of their annual rainfall during the April-October period, such as the Darling Downs South West region and southeast Queensland.

Parts of southern and western Queensland have been in drought for more than six years (Queensland Government 2019). By contrast, in far north Queensland, rainfall has been above average over the past 20-year period (see Figures 7 and 8).

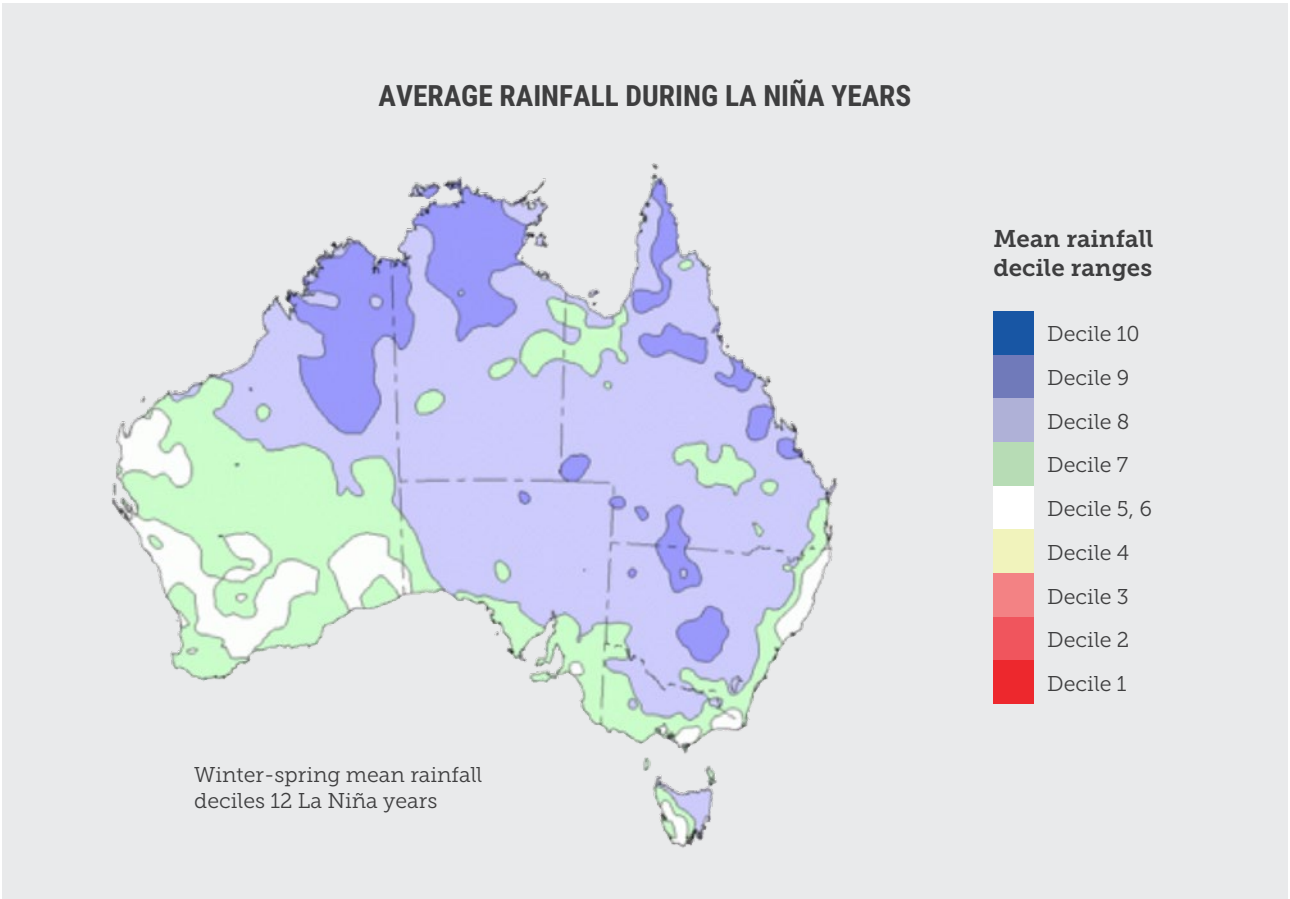


Figure 6: Average rainfall during La Niña years. **Source:** BoM (2019d).

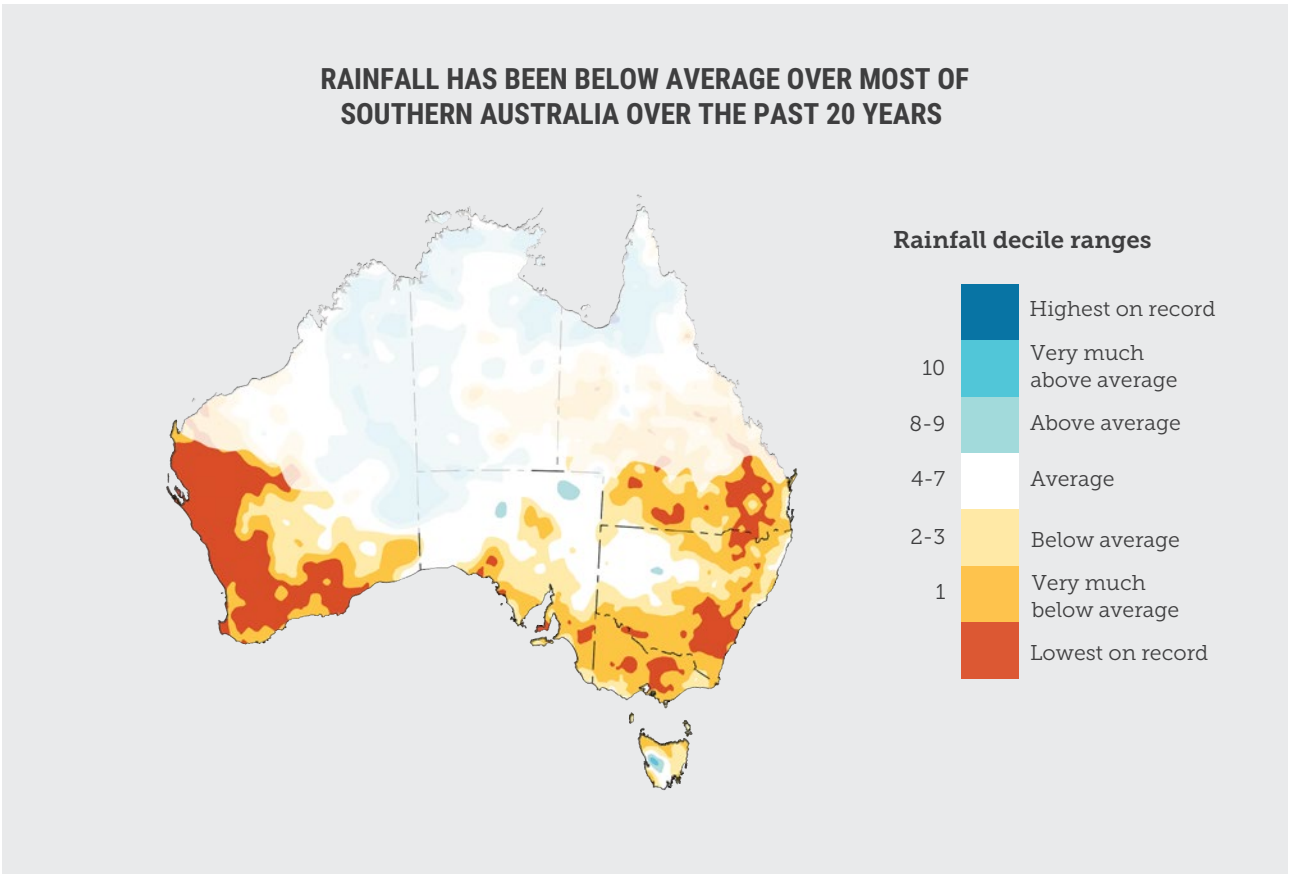


Figure 7: Cool season rainfall has been below average over most of southern Australia over the past 20 years (in comparison with the entire rainfall record from 1900). Areas that derive less than 40% of their annual rainfall during the April-October period are faded in the map. **Source**: CSIRO and BoM (2018).

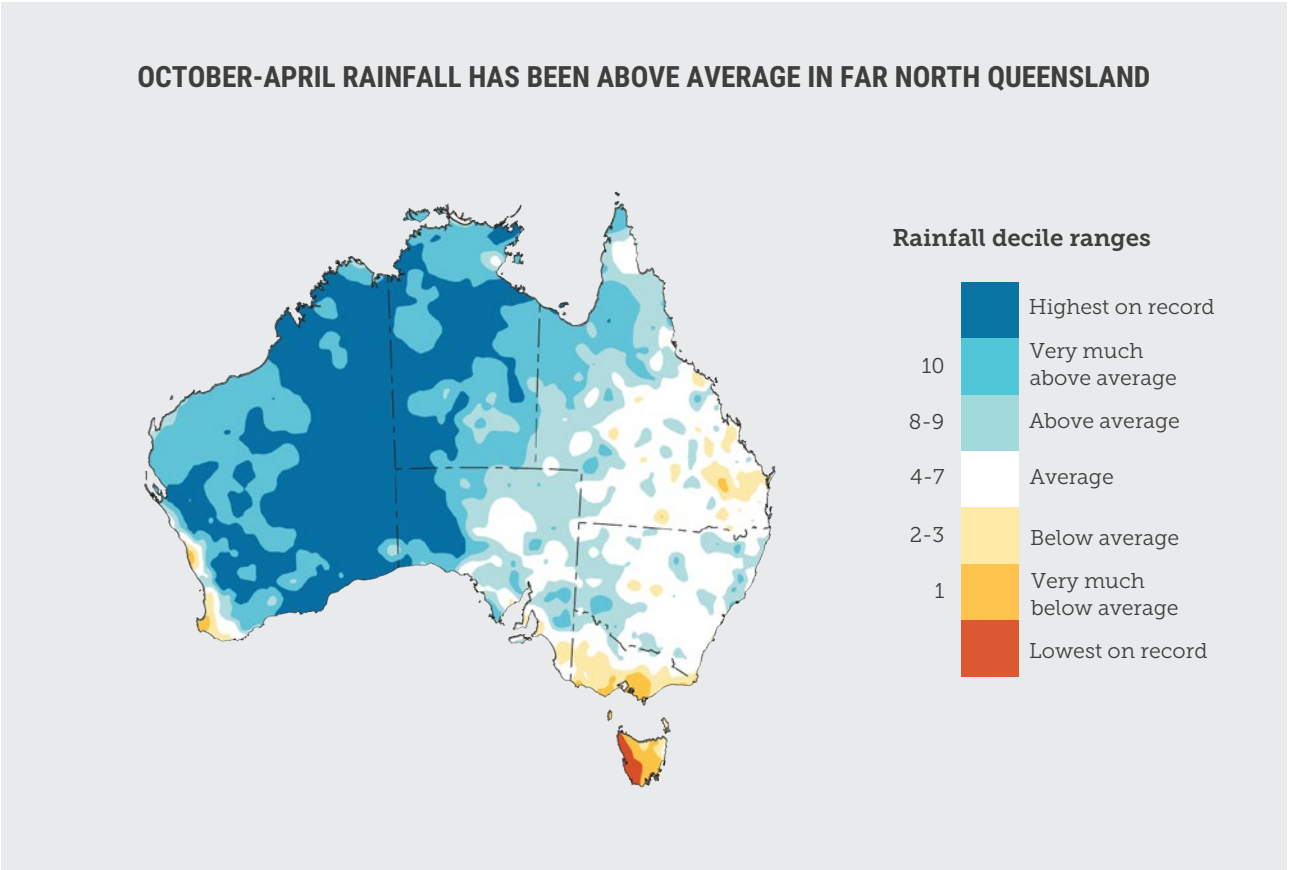


Figure 8: October-April rainfall has been above average in far north Queensland over the past 20 years (in comparison with the entire rainfall record from 1900). **Source**: CSIRO and BoM (2018).

Queensland has very high exposure to flood risks, and climate change is increasing the intensity of short-duration downpours, increasing the risk of flooding.

Climate change is already impacting the intensity of short-duration rainfall events, and this is projected to continue. This means that, when it does rain, it's more likely to be heavier and cause hazardous flooding. For heavy rain days, total rainfall is expected to increase by around 7% per 1°C of warming (based on the physical relationship of temperature and the moisture-holding capacity of the atmosphere). There is evidence from observed weather station records that a higher proportion of total annual rainfall in recent decades has come from heavy rain days. Observed increases in the magnitude of *hourly* rainfall extremes are close to or more than double this expected rate of precipitation over most areas of Australia (mm/hr), and in the tropical north of Australia, the magnitude of hourly rainfall extremes is triple this expected rate (Guerreiro et al. 2018).

Climate change is expected to increase the occurrence of flooding events due to an increase in short-duration heavy rainfall events. Queensland has a very high exposure to flood risks, with 16 out of the top 20 most flood prone electorates in Australia being in Queensland, according to the Insurance Council of Australia (see Figure 9) (ICA 2019). Of these 16 electorates in Queensland with high flood exposure, at least five also have high cyclone exposure, increasing overall risks (these are the electorates of Leichhardt, Herbert, Kennedy, Dawson and Capricornia. The electorate of Flynn has also experienced occasional cyclones).

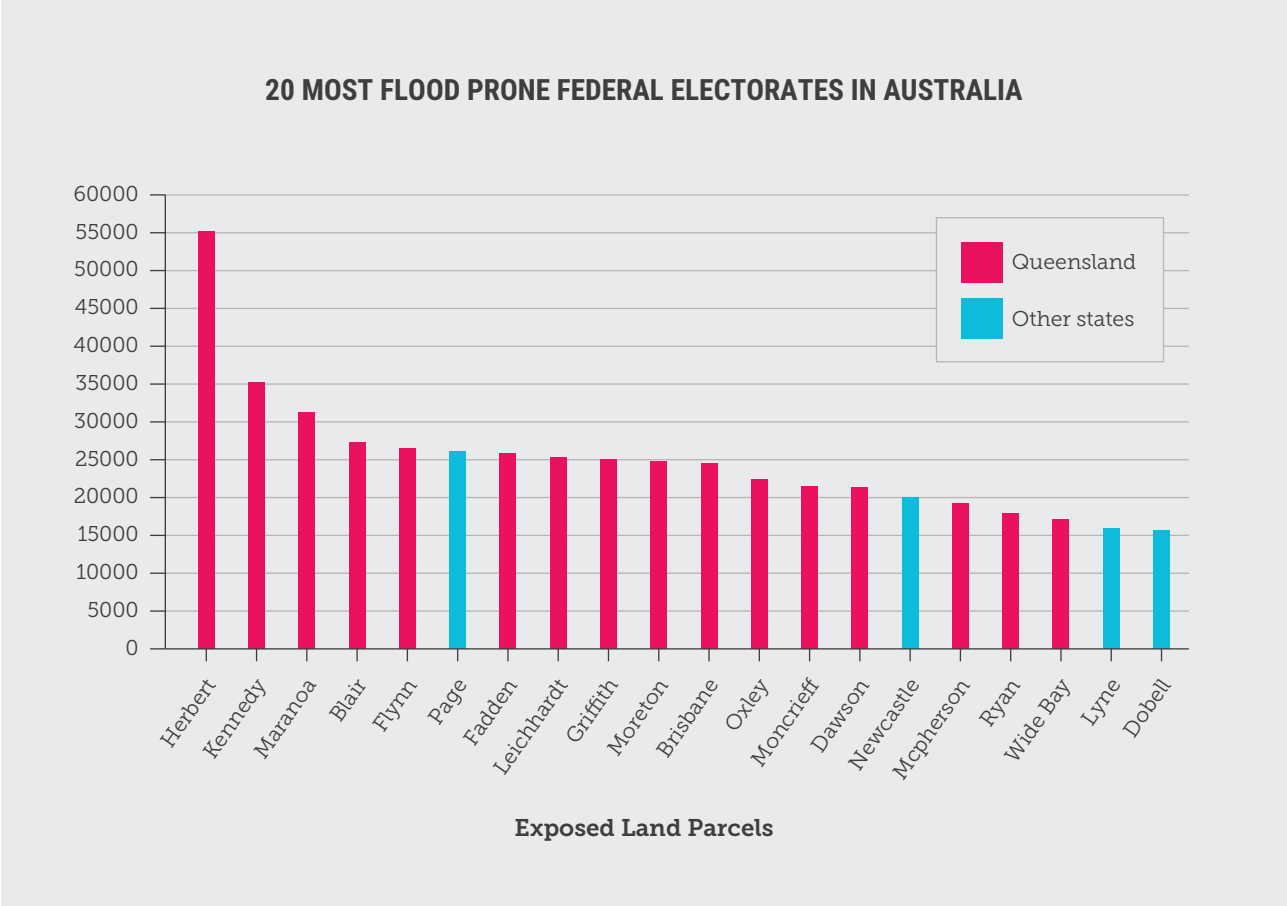


Figure 9: 16 of the top 20 most flood prone electorates are located in Queensland, according to the Insurance Council of Australia (2019).

Townsville, within the electorate of Herbert, contains around 45,000 land parcels with significant flood exposure. In early February, the Townsville area registered record-breaking 10-day rainfall totals (1257.0 mm), overwhelming the capacity of the dam and ultimately flooding low-lying suburbs. Three people died and thousands of properties were affected. Final damage assessments conducted by Queensland Fire and Emergency Services revealed that 2,063 properties experienced floodwater inundation of up to 25 cm, 101 properties experienced inundation of up to 1 metre and 135 properties suffered inundation of over 1 metre (Townsville Bulletin 2019).

Queensland is highly exposed to flooding, with 16 of the top 20 most flood prone electorates located in Queensland.

BUSHFIRES

An increase in fire danger weather has been observed over recent decades across much of Australia. In particular, the annual accumulated forest fire danger index (a sum of FFDI across the year) has been increasing across eastern Australia, including Queensland (BoM 2018). This represents an increase in both the frequency and severity of dangerous fire weather conditions, including a lengthening of the bushfire season. Bushfire risk is increased by fuel dryness and hot, dry, windy conditions. Weekly bushfire frequencies (the average number of bushfires in a week) in Australia have increased by 40% between 2007 and 2013, with tropical and subtropical Queensland the most severely affected (Dutta et al. 2016).

Tropical and sub-tropical Queensland are often associated with warm, humid conditions and moist vegetation not conducive to major bushfires. This is changing. More frequent heatwave events typified by hot, dry air masses coming from the interior drive higher temperatures and lower humidity. This increases evaporation and rapidly dries out fuels, even in rainforests, making conditions more conducive to major bushfires.

In November 2018, Queensland experienced widespread heatwaves accompanied by strong, gusting winds, low humidity and record high temperatures. These conditions fanned devastating bushfires that affected property, infrastructure, ecosystems and farming land. The bushfires also penetrated rainforests. On November 29 several areas of Queensland experienced “catastrophic” fire weather conditions for the first time ever. In these conditions, fires are uncontrollable and loss of life and property is expected unless large-scale evacuations take place. Climate change is causing such conditions to occur more frequently.

Bushfires in Queensland over the years have caused numerous deaths and losses of property and infrastructure, and have negatively affected agricultural and forestry production, and ecosystems. Inhalation of smoke and gases from bushfires can affect human health, especially the health of the elderly, young or those with heart or respiratory conditions (Johnston et al. 2011; Johnston et al. 2014). Increasing severity, intensity and frequency of fires, coupled with increasing length of bushfire seasons throughout Australia, is straining Queensland's existing resources and capacity for fighting and managing fires. Overlapping fire seasons will increasingly restrict the ability of states and territories, and of other countries such as the USA, Canada and New Zealand, to send firefighting assistance. This will drive increased costs for state and territory governments, or alternatively, increased losses.

Figure 10: The bushfires in central Queensland in late 2018 had a devastating effect on the region, especially in Finch Hatton and Eungella west of Mackay (pictured).

SEA LEVEL RISE, COASTAL EROSION AND INUNDATION

Climate change has already led to a rise in global mean sea level of around 20cm since the late 1800s. The IPCC (2014) has indicated a likely (66% probability) that global mean sea level will rise between 0.36–0.71m if temperatures rise around 2°C or between 0.52–0.98m if emissions continue rising on a business-as-usual trajectory.

The IPCC projections do not capture the potential contributions from melting of the marine-based sectors of the Antarctic ice sheet. More recent publications indicate that a global mean sea level rise of up to 2.5m is possible by 2100 if the contribution from melting ice sheets is factored into projections (NOAA 2017). Delays in cutting emissions increase the risks of Antarctic ice sheet collapse.

Higher sea levels contribute to an increase in storm-surge damage, as waves ride on higher seas. The distribution of storm-tide damages in Australia is very uneven, with over 80% of damages expected to occur in Queensland. The most highly affected area, the Gold Coast, alone accounts for almost a quarter of projected national damages (Wang et al. 2016). This is because of the large amount of development and infrastructure near the shoreline.

At present, an estimated 226,500 people in southeast Queensland are at risk of inundation from a 1-in-100-year storm tide. Tidal areas in this region include the coast and areas open to the coast via tidal rivers, such as Brisbane.

The effects of climate change alone on sea-level rise could see this number increase to about 245,100 people by 2030 and 273,000 people by 2070 (Wang et al. 2010). The cost of a 1-in-100-year storm tide in Queensland is around $1.1 billion today, and would rise to $1.3 billion by 2030 and $1.5 billion by 2070. These figures assume planning controls are implemented that prevent any new developments in flood prone areas. Projected damages would be much higher if these planning controls are not implemented.

If new buildings continue to be built in areas that are highly exposed to coastal erosion and inundation risks, the number of exposed people could substantially increase (Wang et al. 2010). For planning purposes, the Queensland Government has adopted climate modelling indicating a projected sea level rise of 0.8m by the year 2100, based on modelling from the IPCC (2014). This is based on the median value of the 'business-as-usual' scenario, which assumes that the current rate in growth of greenhouse gas emissions remains the same going forward but does not factor in the significant increase in sea-level rise if parts of the Antarctic ice sheet collapse.

TROPICAL CYCLONES

As ocean temperatures increase, tropical cyclone intensity is expected to increase, both in terms of maximum wind speeds and in the intensity of rainfall that occurs in association with cyclones. Storms draw energy from the surface waters of the ocean, and as more heat is stored in these upper waters, cyclones have a larger source of energy on which to draw (Emanuel 2000; Wing et al. 2007). A preliminary analysis of observations of global tropical cyclone activity shows that intensification of cyclones is likely to be occurring already (Rahmstorf et al. 2018; Figure 11).

In the southern hemisphere and Australian region, there is a general tendency for climate models to project an overall decline in the frequency of tropical cyclones (Walsh et al. 2012; Walsh 2015). However, it is likely that the intensity of tropical cyclones will increase, leading to an increase in the percentage of severe tropical cyclones (Category 4 and 5) (Emanuel et al. 2008; Leslie et al. 2007; Lavender and Walsh 2011; Abbs 2012). A greater proportion of storms may reach south of latitude 25 degrees South (i.e. south of Bundaberg near Fraser Island and into southeast Queensland) (CSIRO and BoM 2015).

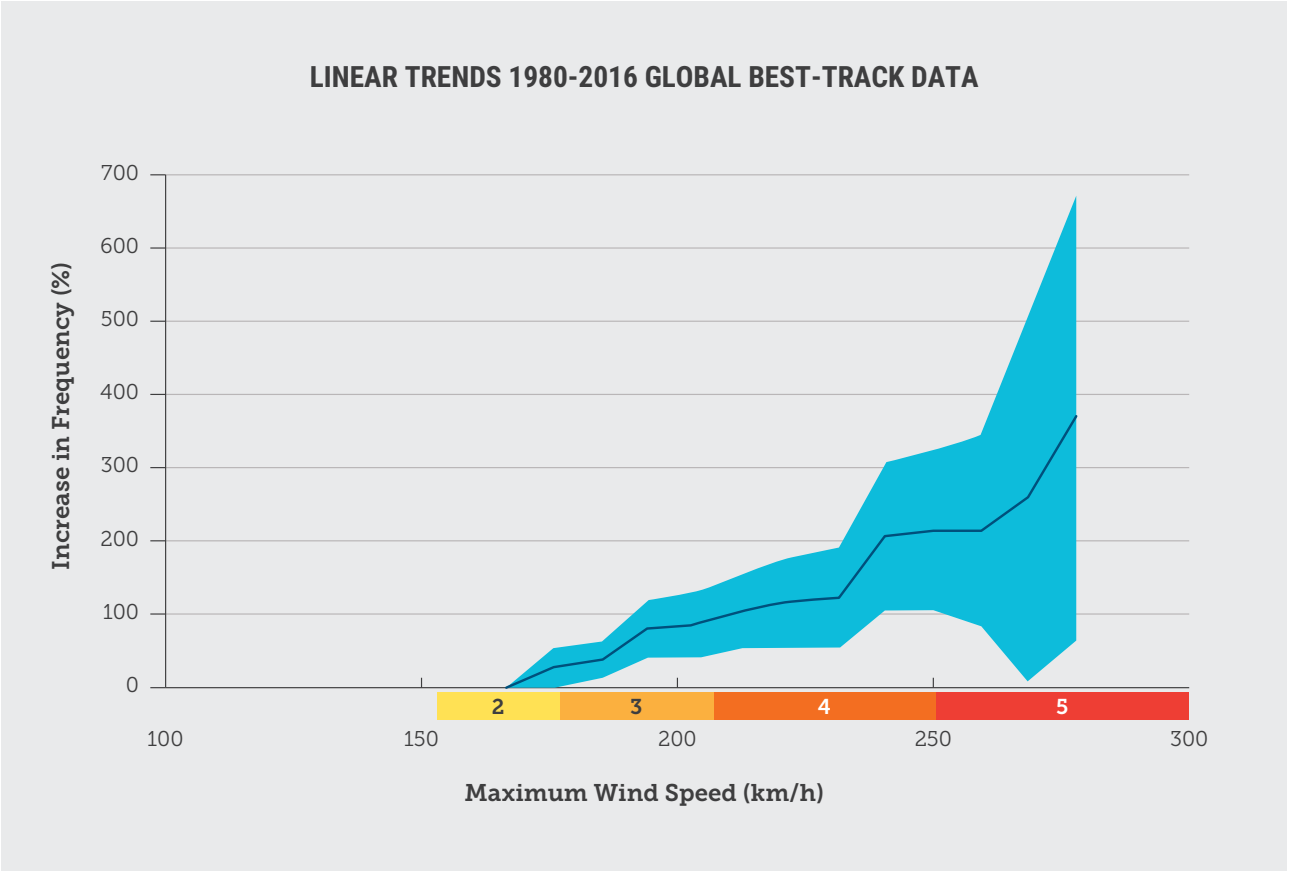


Figure 11: Percentage increase 1980 to 2016 in the number of tropical storms worldwide depending on their strength. Only 95% significant trends are shown. Colours show the cyclone/hurricane category on the Saffir-Simpson scale. **Source**: Kerry Emanuel, MIT, cited in Rahmstorf et al. (2018).

3. Health Impacts

Climate change is already affecting the health of Queenslanders in numerous ways. Extreme weather events such as bushfires, floods and cyclones, which are becoming more frequent and/or severe due to climate change, increasingly place the lives of Queenslanders and visitors at risk, as well as increasing the risk of injuries, placing pressure on emergency services and endangering the lives of emergency service workers.

In addition to immediate danger from physical hazards, extreme weather can result in ongoing health impacts, including increasing risk of infectious diseases, mental health issues and post-traumatic stress. For example, the Queensland floods in 2011 resulted in $7.4 billion worth of health and social costs alone (greater than the tangible costs to disruptions in commerce and damage to infrastructure) (Deloitte 2016). These impacts can last several years or a lifetime; flood victims were 5.3 times more likely to report poorer health compared to those not affected by the floods and 2.3 times more likely to report post-traumatic stress disorder (Deloitte 2016). Damage to critical infrastructure such as electricity and water supply also pose ongoing threats to health in the aftermath of extreme weather events.

Heatwaves have increased in frequency, duration and intensity due to climate change (Perkins and Alexander 2013; Climate Council 2014). Heatwaves are Australia's deadliest natural hazard, having killed more people than all other extreme weather events combined since European settlement in Australia (Coates et al. 2014).[1] Heatwaves increase the risk of heat-related illnesses (such as dehydration and heatstroke), as well as increasing the risk of cardiovascular, respiratory and mental health conditions. Children, older people, outdoor workers, emergency responders, and people with pre-existing illnesses are most at risk. Heat exposure during the heatwave in 2004 in Brisbane resulted in an estimated 75 premature deaths, including an estimated 41 premature cardiovascular deaths (Tong et al. 2010).

[1] Since 1900, heatwaves have been responsible for 4,555 deaths in Australia.

Coal mining, transport and combustion generate air pollutants that are damaging to human health. Queensland has some of the most polluting mines and power stations in Australia.

Climate change also affects human health via its effects on air pollution. Higher temperatures modify the chemical reactions of some pollutants such as particulate matter and ozone. Exposure to these pollutants increases the risk of respiratory and cardiovascular diseases, and premature death (Ebi and McGregor 2008; Kinney 2008). Higher temperatures and higher atmospheric CO_2 concentrations can increase allergenic pollen production in plants and lengthen the pollen season, exacerbating conditions such as allergic asthma and allergic rhinitis (hay fever) (Ziska and Beggs 2012). Excess moisture, humidity and pooling of water following cyclones and floods often results in the growth of moulds and fungi, which can cause a range of respiratory illnesses. Climate change may also indirectly reduce air quality and health by increasing the occurrence of bushfires and dust storms. The 2009 dust storm that affected the east coast of Australia resulted in a 39% increase in hospital emergency department admissions in Brisbane (Barnett et al. 2012).

Coal mining, transport, and combustion generates a range of air pollutants that are damaging to health. Coal-fired power stations are the main source of fine particulate matter, oxides of nitrogen and sulphur dioxide in Australia; the resulting cost to the health system is an estimated $2.6 billion per year (AATSE 2009). Coal mines are the main source of coarse particulate matter. The Gladstone power station in Queensland released 46 million kilograms of oxides of nitrogen in 2017-18, more than any other power station in Australia. The Tarong power station in Queensland released more fine particulate matter than any other power station in Australia in 2017-18 (two million kilograms) (EJA 2019a).

Eight of the top ten worst emitting coal mines for coarse particulate matter nationally are in central Queensland (EJA 2019b), putting the lives of those in surrounding communities at risk. Coal mining is also a major occupational hazard; exposure to coal dust by workers has led to a recent re-emergence of the life threatening 'black lung' disease (coal workers' pneumoconiosis) in Queensland, with 21 reported cases in 2015 (Queensland Parliament 2017).

Figure 12: The Gladstone coal power station (pictured) released more oxides of nitrogen in 2017-18 than any other power station in Australia. Coal power stations have a range of negative human health impacts.

Higher temperatures and shifting rainfall patterns may affect the range and prevalence of infectious diseases whose transmission involves vectors or animal hosts. For example, climate change may broaden the geographic distribution of mosquitoes that transmit the dengue virus, facilitating transmission further south in previously cooler regions. Dengue is not continuously present in Australia. However, mosquitoes that transmit the dengue virus – the *Aedes aegypti* and *Aedes albopictus* mosquitoes – are established in parts of Queensland (the latter is only established in the Torres Strait) (Queensland Government 2018). Occasionally, dengue outbreaks occur in north Queensland when the virus is brought in by infected travellers and transmitted by the local *Aedes aegypti* mosquito (for example, in 2009 an outbreak occurred and more than 1000 cases of dengue were recorded, which had far reaching consequences such as reducing the national supply of donated blood as donations from affected areas were suspended). However, north Queensland towns such as Townsville, have had recent success in curtailing outbreaks in recent years (at a cost of $15 per person) by releasing *Aedes aegypti* infected with Wolbachia bacteria. Wolbachia bacteria interfere with the workings of the dengue fever virus in the mosquitoes (BBC 2018).

Aedes aegypti thrives in urban areas and Australia is projected to have one of the largest increases in human exposure from climate change alone due to our large urban populations that are adjacent to current transmission areas (Ebi and Nealon 2016). The probability of dengue virus being carried back to Australia by travellers and transmitted via local *Aedes aegypti* will also increase as the global incidence of dengue increases with climate change. Over the past 50 years alone there has been a 30-fold increase in the global incidence of dengue (Ebi and Nealon 2016). These factors will make the task of controlling dengue more difficult, and may necessitate increased investment in control measures. As the *Aedes aeqypti* mosquito also transmits zika and chikungunya, these illnesses are potential emerging threats for Queensland.

Figure 13: Extreme weather events in Queensland, such as flooding in central Brisbane in 2011 (pictured), are causing significant economic damage. Climate change is driving more extreme weather events.

Climate change also threatens food and water security for Queenslanders. Extreme weather events such as floods, cyclones, and heatwaves can severely disrupt food supply chains, which are dependent on power, water, communications, transport and financial services for the continuity of production, processing, distribution and retail (DAFF 2012). The Queensland floods cut off the town of Rockhampton (population of 75,000) by road, rail and air for two weeks, threatening food security. Brisbane, the state capital, also came within a day of running out of bread (DAFF 2012). The food supply chain has been relatively resilient in dealing with one severe disaster at a time, but could be highly vulnerable to the cumulative effects of multiple disasters (DAFF 2012). Rising average temperatures and shifting rainfall patterns also threaten to reduce food production and quality in the long-term, whilst droughts and other extreme weather events can cause serious short-term reductions in food production.

Extreme weather events also jeopardise water security by increasing contamination risks and causing interruptions in the functioning of water treatment plants. Tropical Cyclone Marcia, which made landfall near Rockhampton in February 2015 as a Category 5 storm, downed power lines resulting in the loss of power to the Glenmore Water Treatment Plant. After the event, elevated levels of manganese were found downstream of the water treatment plant, lasting for approximately two weeks, including one day when the health guideline for manganese was exceeded (Khan 2017). The pools of water left following rainfall of a flood event can also provide additional breeding habitat for disease transmitting mosquitoes such as *Aedes aegypti* or can result in increased risk exposure to other water-borne or soil-borne diseases. Following the Townsville floods in February 2019, at least 11 people were infected by melioidosis, a soil-borne bacteria that was stirred up by the floodwaters, with one person dying from the disease (The Guardian 2019).

4. Risks and Opportunities for Queensland's Economy

Queensland has a diverse and modern economy, which is heavily dominated by the services industries. The largest industry in terms of jobs provision is health care and social services, and the second largest is retail trade (ABS 2019a). Whilst tourism isn't classified as a separate industry, it contributes substantially to Queensland's employment through a variety of industries including accommodation and food services and retail trade. In 2016-17, tourism employed an estimated 217,000 Queenslanders, including about 138,000 direct jobs, representing growth of 2.2% over the previous year (Tourism and Events Queensland 2018). In 2017-18, agriculture, forestry and fishing employed around 66,000 Queenslanders and mining employed 63,000 Queenslanders (ABS 2019a). There were about 25,000 jobs in coal mining in 2016 in Queensland (including both thermal and metallurgical coal mining) (ABS 2016).

In 2017-18 mining made up around 13% of Gross State Product (GSP) ($38.8 billion), and mining exports (e.g. of coal, LNG and minerals) accounted for 60% of goods and services exports from Queensland (Queensland Treasury 2019; ABS 2019b). In the same year, the construction industry accounted for 10% of GSP (worth $29 billion); health care and social assistance contributed 8% to GSP, and professional, scientific and technical services contributed 7% ($20 billion). The education and training sector contributed 6% ($17 billion). Although not counted as a separate category by the Australian Bureau of Statistics, tourism contributed $11.7 billion to the Queensland economy in 2016-17 (latest available), which is captured in various other industries in Figure 14, such as accommodation and food services (Queensland Treasury 2019). Agriculture, forestry and fishing contributed $11 billion to Queensland's economy (4%) (ABS 2019b).

The unemployment rate in Queensland has been falling since 2014-15, from 6.2% to around 6%, which is still higher than the national average of 5.1% (Queensland Government 2019a). Despite the recent fall in the unemployment rate, unemployment in parts of regional Queensland remains high. For instance, in 2017-18 unemployment in the outback was 10.9%, whilst unemployment in the Wide Bay region and Townsville were 9.6% and 9.1% respectively (Queensland Government 2019b).

Jobs in the mining industry in Queensland peaked in November 2013 at 80,600 jobs and have declined since then by around 14,000 jobs. This decline has been more than offset by a growth in jobs over the same period in Queensland's service industries including health (52,000 new jobs), education (47,000 new jobs), professional services (14,000 new jobs) and accommodation and food services (60,000 new jobs) (ABS 2019a). Employment projections suggest that growth in employment over the next five years (to 2023) will also primarily come from the services sector, especially, health care and social assistance, education and training, and construction (Department of Jobs and Small Business 2018).

Queensland's economy faces myriad climate change risks from a business-as-usual emissions scenario, including the impacts outlined in this report. The indicative cumulative damages from a small range of climate change impacts are estimated to be $171 billion for Queensland by 2030, $223 billion by 2050 and around $1.5 trillion by 2100 (Kompas et al. 2019). These damage estimates focus on a limited array of impacts such as loss of agricultural and labour productivity, limited health effects, and reduced property values.

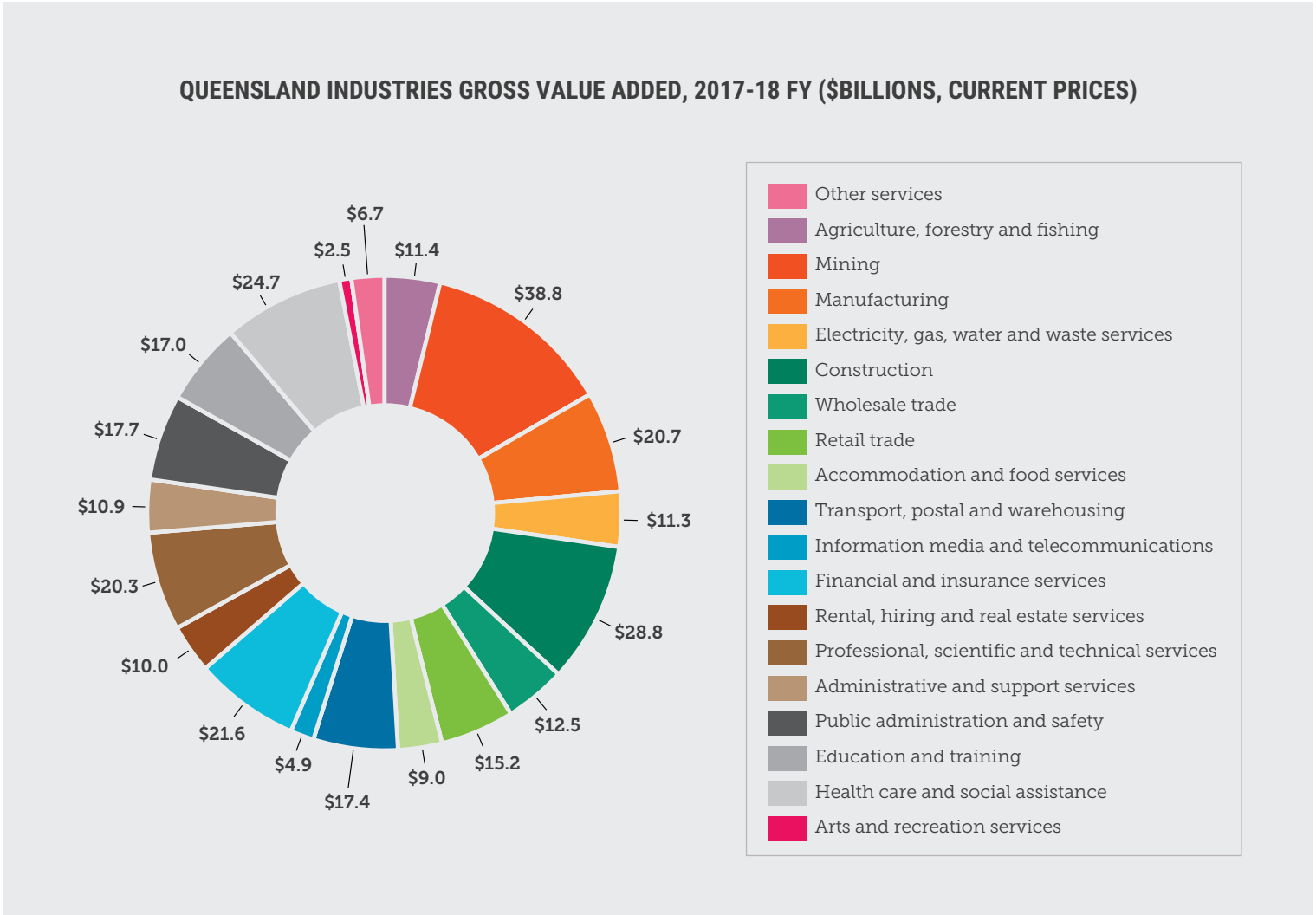


Figure 14: Queensland has a modern and diverse economy dominated by services. **Source:** ABS (2019b).

Risks to the thermal coal mining industry will increase as demand dwindles due to the rapidly falling price of renewable energy. Renewable power is already cheaper than coal power in many parts of the world, and the costs of renewable energy and batteries continue to fall rapidly (IRENA 2019). There are more opportunities and benefits than risks and costs for Queensland's economy from a global and local shift to net zero emissions. A global shift to net zero emissions would bring increased demand for critical minerals in Queensland, which are needed for technologies such as solar panels, batteries and electronics (Ernst and Young 2019).

Demand for renewable-generated hydrogen is also growing, driven by countries in Asia such as Japan, South Korea and Singapore. Queensland is well placed to capitalise on this growing opportunity, given its proximity to markets, its plentiful renewable energy resources, its skilled workforce and existing pipeline and export infrastructure (DSDMIP 2019). Queensland already has two hydrogen pilot projects, and the state government has announced $19 million to kickstart the Queensland Hydrogen Industry Strategy. The renewable generated hydrogen industry could have enormous economic benefits for Australia, generating thousands of jobs and $1.7 billion in export revenue annually by 2030 (DSDMIP 2019). Opportunities such as renewable generated hydrogen present opportunities for replacing export income from reductions in thermal coal exports.

BOX 1: OPPORTUNITIES FOR MOUNT ISA IN THE GLOBAL TRANSITION TO A CLEAN ENERGY ECONOMY

Demand for the minerals and materials required for the global transition to a clean energy economy are expected to rise steeply in the years and decades ahead if the international community meets the goals of the Paris Agreement to limit global average temperature rise to well below 2°C or 1.5°C. Metals that could see growing demand include aluminium (including its key constituent, bauxite), lithium, nickel, cobalt, copper, lead, iron ore, manganese, silver, steel, titanium, zinc, the platinum group of metals, and rare earth metals including cadmium, molybdenum, neodymium, and indium (Arrobas et al. 2017). The most pertinent example of this is the rise in demand for electric storage batteries, which would drive an increase in demand for aluminium, cobalt, lead, iron, lithium, nickel and manganese by more than 1000 percent in a 2°C scenario compared to a 4°C scenario (Arrobas et al. 2017). Demand for copper, iron, lead, molybdenum, nickel and zinc could quadruple through 2050 from increased demand for solar panels alone in a 2°C scenario compared to a 4°C scenario (Arrobas et al. 2017).

The North West Minerals Province, centered around Mount Isa and Cloncurry, is one of the world's richest mineral producing areas, containing copper, lead and zinc as well as major silver and phosphate deposits and rare earth potential (State of Queensland 2017). The resources sector in the region has faced challenges in recent times as several older operations have closed, and lower commodity prices have limited investments in exploration. However, an increase in demand has improved commodity prices in recent times (State of Queensland 2017).

While seizing the opportunities that the increased demand for minerals offers in the shift to a decarbonised economy, a determined effort to combat adverse health outcomes will need to be prioritised so that communities don't suffer the effects of exposure to lead or other heavy metals. For example, to manage the health risks of lead mining and smelting in Mount Isa, it is important to fund universal blood lead level testing, follow-up and intervention for those with blood lead levels of 5 µg/dL (micrograms per decilitre) or greater. As indigenous children have been found to have higher blood lead levels than non-indigenous children, specific outreach programs for indigenous communities are needed. Finally, control of emissions and remediation of existing contaminated areas must be prioritised (Green et al. 2017).

5. Queensland has World Class Renewable Resources

GOVERNMENT POLICIES

Queensland is called the Sunshine State for good reason. The state has become the Australian home of large-scale solar due to its excellent solar radiation and supportive state government policies. The Queensland Government has set a net zero emissions target for 2050 and has committed to a 50% renewable energy target by 2030.

Queensland is the Australian home of large-scale solar due to its excellent solar resources and supportive state government policies.

The state government has recently set up a new state-owned renewable energy generator called CleanCo that is expected to begin trading at the end of October 2019. It will initially include the existing Barron Gorge, Kareeya and Koombooloomba hydro power stations in far north Queensland and the Wivenhoe pumped hydro energy storage facility. It will also include the Swanbank E gas power station. The organisation will have $250 million to invest in new generation, like wind and solar and the state government recently announced ten big renewable and storage projects that will compete for contracts with CleanCo (RenewEconomy 2018). The Queensland Government, in collaboration with ARENA, has also provided $100 million to support investment in 150MW of large-scale solar, which could produce enough electricity to power roughly 45,000 homes for a year (Queensland Government 2019d).

The Queensland Government is providing interest-free loans for households to install rooftop solar and home batteries. These loans of up to $10,000 for combined solar and battery systems can help reduce household power bills while reducing pressure on the electricity grid during periods of high energy demand, making the grid more reliable for all households (Queensland Government 2019e). The state government is also trialling rooftop solar on 4,000 government-owned homes (Queensland Government 2019e).

A target for one million rooftop solar installations or 3,000MW of rooftop solar capacity by 2020 has been set. Queenslanders are embracing rooftop solar in record numbers, lowering electricity costs for families and businesses, creating jobs and reducing greenhouse gas emissions (Queensland Government 2018c).

In order to support the transition away from fossil fuels to renewable energy, the Queensland Government has established a Just Transition Group to support workers and communities in the energy sector as the transition occurs (Queensland Government 2019f). Queensland can continue to be a leader in renewable energy by pursuing strong policies that support the industry, create jobs, attract investment and reduce greenhouse gas pollution.

Figure 15: Workers installing solar panels on the Kidston solar farm, located north-west of Townsville in North Queensland. Renewable energy can create thousands of new jobs, especially in regional areas.

RENEWABLE ENERGY GENERATION

Queensland sourced around 8.8% of its electricity from renewables in 2018, with 75% of energy generation coming from coal and the rest coming from gas and oil. Despite the large proportion of electricity that still comes from coal, renewables are on the rise. Renewable energy generation in Queensland increased substantially from 6.8% in 2017 to 8.8% in 2018 (DEE 2019a). This follows smaller increases over the previous three years.

For more information on how Queensland compares to other states and territories on renewable energy, read the Climate Council's report:

Powering Progress: States Renewable Energy Race.

QUEENSLAND IS A LEADER IN RENEWABLE ENERGY CONSTRUCTION

Queensland has continued to lead Australia in the construction of new renewable energy projects, with ten projects totalling 974MW under construction in 2019, the second highest number of renewable energy projects of any state in Australia (CER 2019). This is almost two-thirds the capacity of Queensland's largest and oldest coal power station, the Gladstone power station. Queensland is home to the largest number of large-scale solar farms under construction of any state.

The renewable energy construction boom is overwhelmingly occurring in north and central Queensland, home to some of the best solar resources in the world. The region hosts six of the ten renewable energy projects under construction or about to begin construction, as well as eleven of the fifteen projects that began operating in 2018 (CER 2019).

North and central Queensland are home to six of the ten large-scale renewable energy projects under construction in Queensland.

Renewable energy projects under construction or about to begin will create over 4,500 jobs and deliver almost $10 billion in investment to Queensland.

According to the Clean Energy Council (2019), renewable energy projects under construction or about to begin will create over 4,500 jobs in Queensland and deliver almost $10 billion in investment. This is in addition to the 5,080 current jobs in the sector, which is more renewable jobs than in any other state or territory (ABS 2019c). A list of renewable energy projects under construction or about to begin by region are included in Table 1. Once these projects are operating, they should propel Queensland forward to much higher levels of renewable energy generation in the next few years. This ongoing construction is on top of the dozens of renewable energy projects that were completed in 2018. The 15 largest projects that began operating in 2018 are listed in Table 2.

Table 1: Six of the ten renewable energy projects under construction or about to begin construction in Queensland are in north and central Queensland (highlighted in bold).

Project	Size (in megawatts)	Region
Haughton solar farm	100MW	Townsville
Clermont solar farm	75MW	Southwest of Mackay and northwest of Rockhampton
Cape York solar and storage project	55MW	Southwest of Cooktown
Kennedy wind farm	43MW	North Queensland, between Townsville and Mt Isa
Middlemount solar farm	34MW	Southwest of Mackay and northwest of Rockhampton
Kennedy solar farm	15MW	North Queensland, between Townsville and Mt Isa
Coopers Gap wind farm	453MW	Near Cooranga North, between Dalby and Kingaroy
Yarranlea solar farm	100MW	West of Toowoomba
Warwick solar farm	64MW	South of Toowoomba
Maryborough solar farm	35MW	Near Maryborough, south of Bundaberg

Source: CER (2019). Table current as at May 2019.

Eleven of the fifteen wind and solar projects that began operating in 2018 are located in north and central Queensland.

While the national Renewable Energy Target is a key driver of many of these projects, Queensland's excellent renewable energy resources and state government support have also been important in making Queensland home to the largest amount of renewable energy construction of any state or territory in Australia in 2018 (Clean Energy Council 2019).

Table 2: Fifteen wind and solar projects above 20 megawatts (MW) in size began operating in 2018. Eleven of these are in north and central Queensland (highlighted in bold).

Project	Size (in megawatts)	Region
Daydream solar farm	181MW	Collinsville, south of Townsville and north of Mackay
Mount Emerald wind farm	181MW	Cairns
Sun Metals solar farm	151MW	Townsville
Ross River solar farm	148MW	Townsville
Clare solar farm	128MW	South of Townsville
Emerald solar farm	90MW	Emerald, west of Rockhampton
Whitsunday solar farm	69MW	Collinsville, south of Townsville and north of Mackay
Hamilton solar farm	69MW	Collinsville, south of Townsville and north of Mackay
Hayman solar farm	60MW	Collinsville, south of Townsville and north of Mackay
Ratch-Collinsville solar farm	59MW	Collinsville, south of Townsville and north of Mackay
Hughenden solar farm	20MW	Hughenden, between Townsville and Mt Isa
Darling Downs solar farm	138MW	Near Dalby, northwest of Toowoomba
Susan River solar farm	96MW	Near Maryborough, south of Bundaberg
Childers solar farm	75MW	Near Childers, south of Bundaberg
Baking Board solar farm	20MW	Near Chinchilla, northwest of Toowoomba

Source: CER (2019).

QUEENSLAND IS NUMBER ONE FOR ROOFTOP SOLAR

Queensland continues to be a leader in rooftop solar both in Australia and internationally. One third of all households (33.3%) have now installed solar PV, more than any other state or territory in Australia (APVI 2019). With almost 600,000 rooftop solar households, Queensland has the highest number of installations in Australia (CER 2019).

The Queensland Government has also installed solar in the remote community of Lockhart River in far north Queensland, with 750 solar panels installed on the roofs of schools and other government buildings. The electricity produced by these panels can be used by the whole community. Solar provides about 10% of the community's energy needs, helping to reduce Lockhart River's reliance on expensive and polluting diesel (Queensland Government 2018b).

There are now 34 Australian suburbs and towns where over 50% of dwellings have installed rooftop solar (APVI 2019), with 25 of these in Queensland. Eight are in South Australia and one in New South Wales. The top 10 solar postcodes in Queensland are listed in Table 3.

Figure 16: The rapid uptake of rooftop solar by businesses and households, such as Dobinson's Spring and Suspension in Rockhampton (pictured), have made Queensland a global leader in rooftop solar.

Table 3: Queensland's top solar postcodes. There are 25 Queensland suburbs and towns where over 50% of households have rooftop solar. This includes the suburb of Elimbah in the Moreton Bay region north of Brisbane, where an astounding 70.6% of households have installed solar – an Australian record.

Ranking	Postcode	Suburb/Town	Region	Rooftop solar installations	% of dwellings with rooftop solar*
#1	4516	Elimbah	Moreton Bay	923	70.6%
#2	4280	Jimboomba, South and North Maclean	Logan City	3,479	60.9%
#3	4270	Tamborine	Logan City/Scenic Rim	846	59.6%
#4	4553	Diamond Valley, Mooloolah Valley, Glenview, Palmview	Sunshine Coast	1,279	59.1%
#5	4520	Samford Valley, Cedar Creek, Enoggera Reservoir	Moreton Bay	2,602	57.1%
#6	4512	Wamuran, Bracalba	Moreton Bay	706	56.7%
#7	4156	Burbank, MacKenzie	Southeast Brisbane	582	56.5%
#8	4561	Yandina, Maroochy River, North Arm, Yandina Creek	Sunshine Coast	1,526	56.4%
#9	4228	Tallebudgera, Tallebudgera Valley	Gold Coast	960	56.4%
#10	4124	Boronia Heights, Greenbank, Lyons, New Beith	Logan City	3,728	56.1%

*excluding postcodes with under 1,000 dwellings

Source: APVI (2019)

One third of all households in Queensland have rooftop solar, the highest in the country.

RENEWABLE ENERGY IS CREATING JOBS AND SUPPORTING REGIONAL ECONOMIC DEVELOPMENT

Queensland is already home to the largest number of direct renewable energy jobs in the country, with 5,080 people working in renewable energy in 2017-18, 1,550 people more than in 2016-17 (ABS 2019c). This does not include jobs in other industries that benefit indirectly from renewable energy construction and investment.

Queensland businesses are also taking control of their power bills by transitioning to affordable and reliable renewable energy.

In 2018 Sun Metals zinc refinery opened a solar farm near Townsville. Sun Metals is one of the biggest energy consumers in Queensland, using 900,000MWh of electricity to produce 225,000 tons of zinc every year. High electricity prices led Sun Metals to build a 116MW solar farm south of Townsville that supplies one-third of its electricity needs (RenewEconomy 2018b). This new solar farm will enable Sun Metals to expand its zinc production to 270,000 tonnes per year in 2019. This expansion will create 350 construction jobs and 100 permanent jobs (ABC 2018).

Solar affordably and reliably supplies one-third of the electricity needs of Townsville's Sun Metals zinc refinery.

6. Electric Vehicles

Electric vehicles powered by renewable electricity can reduce greenhouse gas emissions from the transport sector. Transport was Australia's third most polluting sector in 2018 (electricity was the most polluting) (Australian Government 2019).

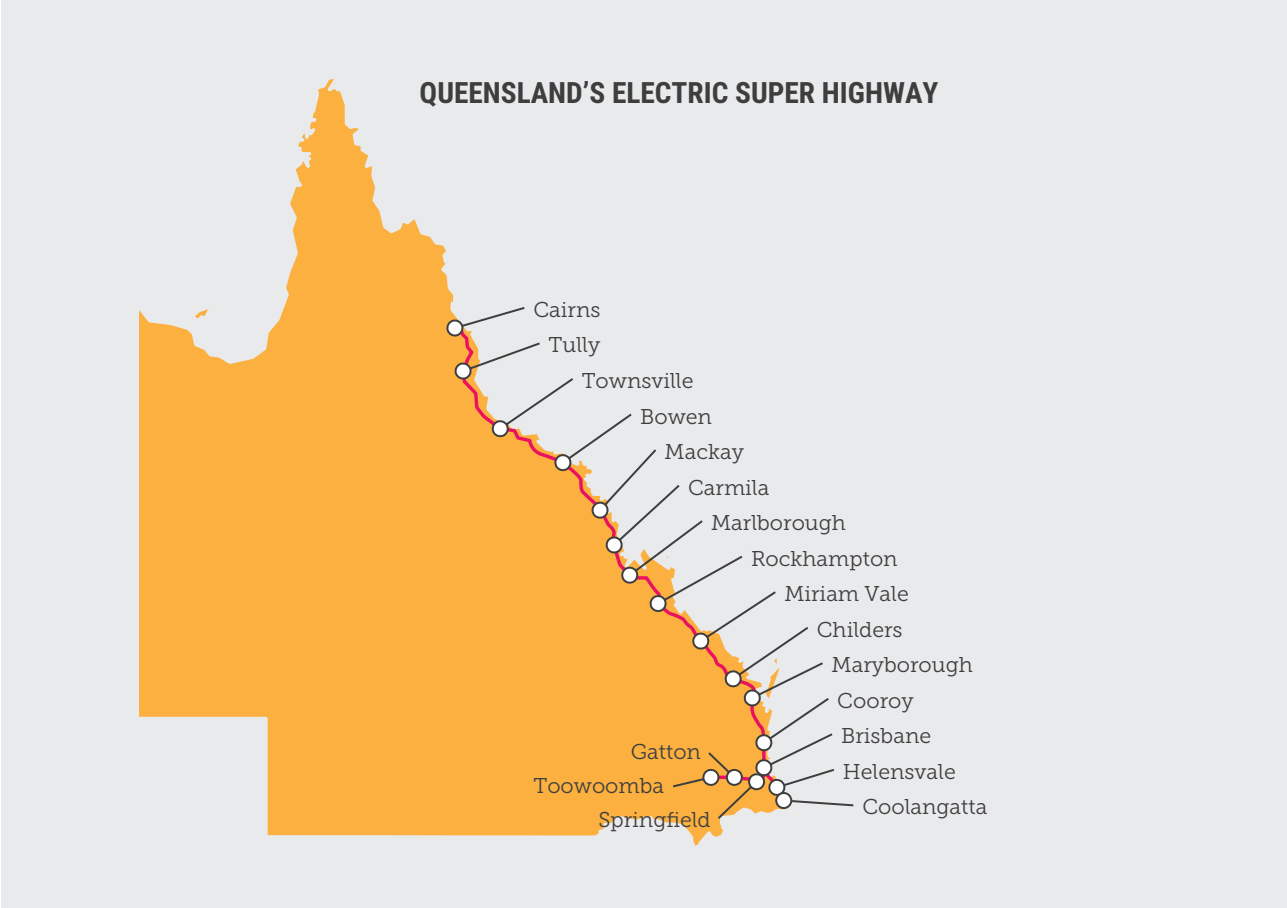
In 2017 the Queensland Government launched *The Future is Electric: Queensland's Electric Vehicle Strategy* to guide Queensland's shift to a cleaner electric vehicle fleet. A core part of the strategy is the Queensland Electric Super Highway, a network of electric vehicle fast charging stations from Coolangatta to Cairns and Brisbane to Toowoomba (Queensland Government 2018c). This extensive charging network enables long trips to be made in electric vehicles. The Queensland Electric Super Highway is the world's longest electric super highway in a single state. The fast chargers have been installed in convenient locations close to major highways where there are existing amenities, such as cafes, restaurants and shops (Queensland Government 2018c).

Air pollution from vehicles is associated with 3000 premature deaths per year in Australia.

There are a range of cost and health benefits to electric vehicles. Electric vehicle charging is estimated to be 60% to 90% cheaper than the fuel costs for fossil fuel vehicles. There would be significant fuel savings created by the transition to electric vehicles as Queensland households currently spend $5.8 billion on fuel each year (Queensland Government 2018d). Electric vehicles also have lower maintenance costs compared to fossil fuel vehicles. It is predicted that by 2025 electric vehicles will have the same upfront costs as fossil fuel vehicles (Queensland Government 2018d).

Fossil fuel vehicle pollution is associated with 3,000 premature deaths annually in Australia. A study conducted by the Queensland Government found that fossil fuel vehicle pollution causes up to 253 premature deaths and 607 cases of respiratory disease each year in Queensland (Queensland Government 2018d).

Figure 17: Queensland's Electric Super Highway, an electric vehicle charging network connecting Cairns and Coolangatta.
Source: Queensland Government (2018c).



Queensland is home to the world's largest electric super highway in a single state.

7. Future Renewable Opportunities for Queensland

The opportunities for Queenslanders in renewable energy are great. Strong government action is required to ensure Queensland reaps the benefits of its world-class renewable energy resources. A series of policies, such as reverse auctions for renewable energy, would help to ensure a range of renewable energy projects come to fruition.

Queensland has previously developed a Powering North Queensland Plan to build new transmission and upgrade hydro power stations (Queensland Government 2019). Transmission is important for connecting the massive pipeline of new renewable energy projects in north and central Queensland to households and businesses. The Australian Energy Market Operator (AEMO) has identified this area as a renewable energy zone, the North Queensland Clean Energy Hub. The region has "excellent quality renewable resources" but currently lacks the transmission capacity to develop these resources (AEMO 2018). Investment in transmission infrastructure to this region could create over 4,600 additional jobs in the region by enabling more renewable energy projects to connect to the grid (Queensland Government 2019d).

Strong state government policies, like renewable energy reverse auctions, could create thousands more jobs for Queenslanders.

Development of the Kidston stage two solar and pumped hydro project is also dependent on new transmission infrastructure. The project near Georgetown, which includes 250MW pumped hydro and 270MW of solar, received a loan of $516 million from the Northern Australia Infrastructure Facility (NAIF 2018).

The immense opportunities in renewable energy for Queensland are not a foregone conclusion. Strong policies and leadership are required to ensure Queensland can meet its ambitious renewable energy targets and create thousands of clean and sustainable jobs in the state.

Figure 18: The Lakeland solar farm and storage facility (pictured) is now producing clean and affordable electricity and supporting jobs in the local area.

8. Queensland Needs a Just Transition Away From Thermal Coal

As well as having plentiful renewable resources, Queensland has enormous coal reserves in places such as the Bowen Basin, the Galilee Basin and the Surat Basin. This means that the coal mining industry, which currently supports around 25,000 jobs in Queensland, is vulnerable as the shift of global markets away from thermal coal to renewable energy continues. It also makes Queensland influential in global efforts to address climate change, because burning thermal coal in power stations to produce electricity produces greenhouse gas emissions that drive climate change.

In recognition that the risks of unmitigated climate change are too high to accept, governments around the world signed and ratified the Paris Agreement, agreeing on the need to limit temperature rise to well below 2°C, and to pursue efforts to limit temperature rise to 1.5°C. Australia signed and ratified the Paris Agreement.

The global carbon budget, which is a scientifically based method for determining how much carbon humanity can "spend" to limit climate change to a specific temperature target, is rapidly running out. For a 66% chance of limiting the global average temperature rise to no more than 2°C, the amount of carbon that can be emitted globally, is about 205 billion tonnes of carbon, emitted as CO_2.[2]

[2] The carbon budget is a scientifically robust approach for considering how many greenhouse gas emissions can be "spent" without causing the Earth's temperature to exceed a given temperature target. The budget is based on the relatively linear relationship between carbon dioxide concentrations and temperature rise. There are a few different factors that influence the size of the carbon budget. The first is the probability of meeting the target (a smaller budget gives a greater probability of meeting the target), the second is accounting for non-CO_2 greenhouse gas emissions (if these are not assumed to be reduced at the same rate, the budget needs to be reduced) and the third is accounting for carbon cycle feedbacks in the climate system (as these kick in, the budget needs to be reduced). The IPCC (2013) estimates that for a greater than 66% probability of limiting global average temperature rise to no more than 2°C, cumulative human emissions since 1870 must be less than 1,000 Gt C (emitted as CO_2). Subtracting the emissions that have been spent to date (585 Gt C) and accounting for non-CO_2 gases (210 Gt C) leaves 205 Gt C. That is a conservative estimate, as it does not account for carbon cycle feedbacks such as melting permafrost (frozen subsoil) in the Arctic, which emits methane, and would therefore further reduce the budget.

Once 205 billion tonnes of carbon have been burned, global CO_2 emissions must be zero to have a good chance of preventing warming from exceeding 2°C. It is very clear from the carbon budget that the combustion of fossil fuels - coal, oil and gas - must be phased out rapidly. The exploitation and burning of fossil fuels leads to an increase in CO_2 emissions, when what is needed is a deep and rapid decrease in CO_2 emissions. To meet the Paris climate target, existing fossil fuels need to be phased out rapidly. Furthermore, it is obvious that no new fossil fuel deposits should be developed.

If the Galilee coal basin were a country, it would rank in the top 15 worst emitting nations in the world. If the Galilee Basin's coal deposits are fully developed, it would release more than 700 million tonnes of carbon dioxide each year – more than 1.3 times Australia's current annual greenhouse gas pollution from all sources (Greenpeace 2012; DEE 2019b).

In response to the Paris Agreement, as well as because of the rapidly falling costs of renewable energy, global markets are shifting away from thermal coal (used to generate electricity). This transition from thermal coal to renewables is inevitable, and is already underway. Renewables are already the lowest-cost source of new power generation in most parts of the world, and the costs of renewable energy technology continue to fall (IRENA 2019). The financial risks associated with thermal coal are now well recognised, and financial institutions are taking steps to lower their exposure. For example, Queensland's largest insurance company, Suncorp, recently announced that it will no longer invest in, finance or underwrite new thermal coal mines or power stations, and will phase out existing thermal coal mines and power stations from its portfolio by 2025. Suncorp was the last major Australian insurance company to make such an announcement (SBS 2019).

For workers, this means that new jobs in thermal coal mines are unlikely to be stable, long-term jobs. There is a clear need for a just transition plan, led by the Federal Government and state governments, to ensure that workers in the thermal coal industry are retrained into other, more secure jobs utilising the skills-base and strengths of individuals and communities.

9. Conclusion

Queensland has much to lose or much to gain, depending on the path that it takes into the future. If climate change continues unabated, and if effective adaptation measures are not introduced to reduce exposure to the impacts of climate change and extreme weather, the economic, health and environmental wellbeing of Queenslanders will be seriously affected. At the same time, Queensland has world class renewable energy resources that can reliably and affordably power the state, supporting jobs and attracting investment. Moreover, embracing renewable energy will help the state reduce its own contribution to dangerous climate change.

It is clear that the combustion of fossil fuels - coal, oil and gas - must be phased out rapidly to avoid the worst impacts of climate change. It is also clear that global markets are shifting away from thermal coal, driven by a range of forces including technology, cost and policy. The future is bright for Queensland, but clear and visionary policies from government are required to take advantage of the numerous economic opportunities in renewable energy, clean transport and other industries. As the global transition to a clean energy economy continues, Queensland can reap the benefits of leadership or, alternatively, face the costs of inaction.

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Page 15: Figure 10 'Eungella Range Road 2.' Image courtesy of the Mackay Conservation Group.

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