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HeatWatch

Extreme heat in Mackay

Increasing extreme heat will have profound impacts on people, industries and ecosystems in Mackay. CSIRO and Bureau of Meteorology projections estimate that the average number of days over 35 degrees could increase from around one day presently to over seventy by 2090 without strong climate policies. Virtually all summer nights by 2090 are projected to remain above 25 degrees, a level considered dangerous to human health.

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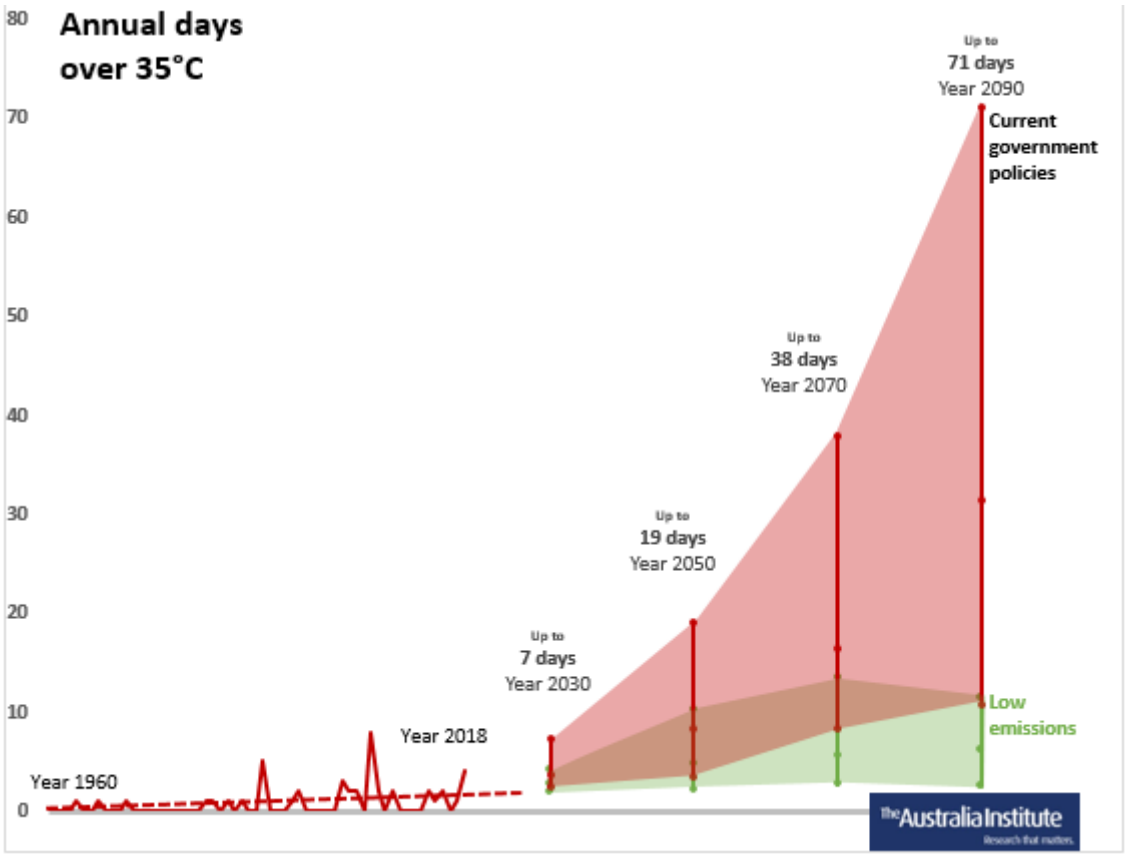
Summary

The projected rise in extremely hot days as a result of global warming presents a serious risk to the health and wellbeing of the Mackay community.

There has already been a clear increase in numbers of these extreme heat days over recent decades. The CSIRO projects this could rise steeply from an average of 1.5 days above 35 degrees, to 19 days by 2050 and potentially 71 days by 2090.

Figure 1: Forecast annual number of days over 35 degrees in Mackay



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Exposure to extreme heat can lead to serious illness and death. At temperatures above 35 degrees, the human body's ability to cool itself reduces which can lead to a cascading series of Heat Related Illnesses (HRI) and ultimately heatstroke that can

cause organ failure and death. Heatwaves have caused more deaths in Australia since 1890 than cyclones, bushfires, floods, earthquakes and severe storms combined.[1]

The extreme heat risk to Mackay is exacerbated by Mackay's high humidity. Over the last year there were 141 days - concentrated in summer - with a relative humidity of 70% or above and 53 days over 80% or above at 3pm in Mackay. Combined with 70% humidity, conditions over 35 degrees are considered "dangerous" by government agencies such as the US Government National Oceanic and Atmospheric Administration. Temperatures of 35 degrees combined with 80% humidity is considered "extremely dangerous".

Cool night time temperatures are essential for good health and allow people to recover from hot days. 25 degrees is considered a threshold for hot nights. The number of nights over 25 degrees in Mackay have also doubled since the 1960s. Alarmingly this could increase over eleven times to a projected 159 nights by 2090 and leave essentially all of summer with extreme heat nights.

Extreme heat events present a risk to critical infrastructure including road, rail and electricity generation and have a major impact on productivity and economic activity.

None of this is inevitable. CSIRO modelling shows that if emissions are reduced decisively in line with the globally agreed target of 1.5 degrees, the number of days per year over 35 degrees could peak at a maximum of 13.5 days around 2070 before reducing to around 11.4 days by 2090, ensuring relatively safe temperatures for our children and grandchildren.

The workforce in Mackay is also particularly vulnerable to increasing extreme heat with 25 per cent of workers employed in industries that frequently require heavy outdoor labour including mining, construction and agriculture.

[1] McMichael et al (2003) *Climate change and human health, risks and responses,* p 53, https://www.who.int/globalchange/publications/climchange.pdf

Introduction

Mackay has historically enjoyed a relatively pleasant coastal climate. However, this is at risk as the climate warms and the number of extreme heat events increases.

Prior to last November the temperature in Mackay had never exceeded 40 degrees since records began in 1960.

However last November Mackay experienced its most extended heatwave on record and its highest recorded temperature of 40.7 degrees, easily breaking a record set just three days before.[2] Mackay also experienced four consecutive days above previous November records, as well as breaking annual records for consecutive days over 35 and 38 degrees.[3]

This intense heatwave triggered a bushfire crisis throughout Queensland, including near Mackay, putting hundreds of homes at risk.[4]

2018 also saw Australia as a whole post its hottest summer on record, and the first season in which temperatures have exceeded two degrees above the long-term averages.[5]

Beyond the impacts increasing extreme heat itself, there are many other connected impacts including the recent bushfire crisis throughout Queensland which was triggered by the unprecedented heatwave that preceded it. Global warming has also already increased the frequency of rainfall disruptions such as the Queensland floods by 30%, which are projected to increase to 90% by mid-century and 130% by 2100.[6]

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[2] BOM (2018) Climate Data online, Mackay Aero, November 24 and 26, http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=122&p_display_type=dailyDataFile&p_startYear=2018&p_c=-218394947&p_stn_num=033045

[3] BOM (2018) Special Climate Statement 67—an extreme heatwave on the tropical Queensland coast, http://www.bom.gov.au/climate/current/statements/scs67.pdf

[4] Daily Mercury (December 2018) *STAY INFORMED: Fires still active in Mackay Region,* https://www.dailymercury.com.au/news/stay-informed-fires-still-active-in-mackay-region/3591424/

[5] Sydney Morning Herald (2019) *'It's been extreme': Australia's summer smashes seasonal heat records,* https://www.smh.com.au/environment/weather/it-s-been-extreme-australia-s-summer-smashes-seasonal-heat-records-20190227-p510od.html

[6] BOM (2017) *Droughts and flooding rains already more likely as climate change plays havoc with Pacific weather,* http://www.bom.gov.au/climate/updates/articles/a023.shtml

EXTREME HEAT

Extreme heat is dangerous for human health, for ecosystems and agriculture. At temperatures above 35 degrees, the human body's main cooling mechanism – sweating – is far less effective. Sweating exchanges heat from the body to the atmosphere, but this heat exchange process diminishes significantly beyond 35 degrees, so body temperature rises. This creates discomfort and a range of health impacts, from mild to severe, and can ultimately be fatal without intervention.[7]

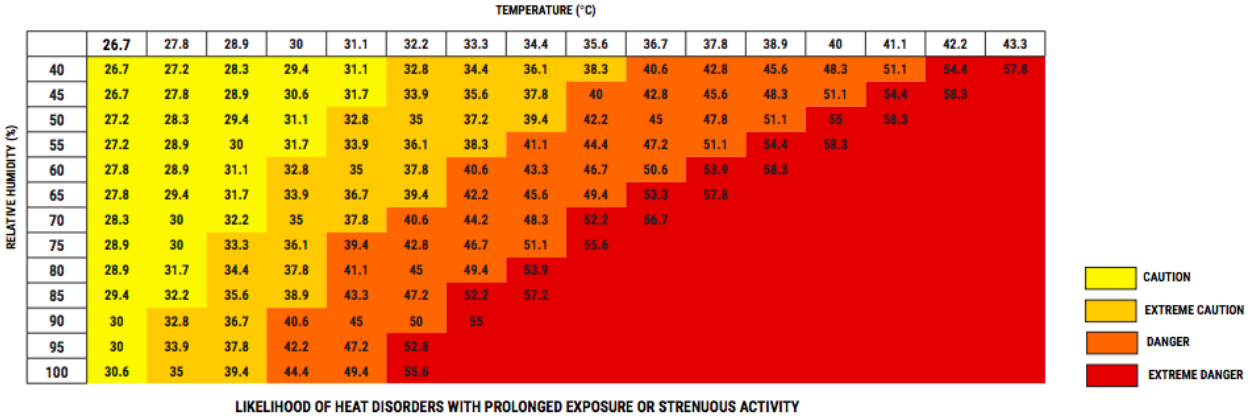
Because of this, many regulators and researchers use 35 degrees as an important threshold for safety, work and climatic conditions. 35 degrees is seen as the "limit of high temperature tolerance" by the Occupational Health and Safety Representatives of the Victorian Trades Hall Council and many academic researchers note it as the point where substantial productivity is lost. The CSIRO and Bureau of Meteorology publish 35-degree threshold predictions.[8]

Temperature and humidity are often combined into a heat index figure to provide a simple indicator of the body's ability to cool itself. Of a number of indices available, one of the most important is published by the US Government National Oceanic and Atmospheric Administration (NOAA). As shown in the NOAA heat stress chart in Figure 1 below, the combination of temperatures in the low thirties with high humidity are considered "dangerous" to human health.

[7] Hanna and Tait (2015) *Limitations to thermoregulation and acclimatisation challenges human adaptation to global warming,* Int J Environ Res Public Health, https://academic.oup.com/heapro/article/30/2/239/561863

[8] Victorian Trades Hall Council (2018) *Heat*, http://www.ohsrep.org.au/hazards/workplace-conditions/heat; Singh et al (2015) *Working in Australia's heat: health promotion concerns for health and productivity,* Health Promotion International, https://academic.oup.com/heapro/article/30/2/239/561863; CSIRO and BoM (2015) *Climate change in Australia: Projections for Australia's NRM Regions*, https://www.climatechangeinaustralia.gov.au/en/publications-library/technical-report/

Figure 2 NOAA Heat Stress Index



	26.7	27.8	28.9	30	31.1	32.2	33.3	34.4	35.6	36.7	37.8	38.9	40	41.1	42.2	43.3
40	26.7	27.2	28.3	29.4	31.1	32.8	34.4	36.1	38.3	40.6	42.8	45.6	48.3	51.1	54.4	57.8
45	26.7	27.8	28.9	30.6	31.7	33.9	35.6	37.8	40	42.8	45.6	48.3	51.1	54.4	58.3	
50	27.2	28.3	29.4	31.1	32.8	35	37.2	39.4	42.2	45	47.8	51.1	55	58.3		
55	27.2	28.9	30	31.7	33.9	36.1	38.3	41.1	44.4	47.2	51.1	54.4	58.3			
60	27.8	28.9	31.1	32.8	35	37.8	40.6	43.3	46.7	50.6	53.9	58.3				
65	27.8	29.4	31.7	33.9	36.7	39.4	42.2	45.6	49.4	53.3	57.8					
70	28.3	30	32.2	35	37.8	40.6	44.2	48.3	52.2	56.7						
75	28.9	30	33.3	36.1	39.4	42.8	46.7	51.1	55.6							
80	28.9	31.7	34.4	37.8	41.1	45	49.4	53.9								
85	29.4	32.2	35.6	38.9	43.3	47.2	52.2	57.2								
90	30	32.8	36.7	40.6	45	50	55									
95	30	33.9	37.8	42.2	47.2	52.8										
100	30.6	35	39.4	44.4	49.4	55.6										

Source: http://www.nws.noaa.gov/os/heat/heat_index.shtml

NOAA's heat stress index rises to "Extreme Danger" at temperatures over 35 degrees combine with 80% humidity.

Mackay already experiences humidity of over 70% for a large proportion of the year. From February 2018 to January 2019 there were 141 days, with a relative humidity of 70% or above at 3pm at Mackay, and 53 days over 80% humidity.[9] It should also be noted that for a month between February and March 2018 there were no figures.

A future of such extreme heat days matched with high humidity represents a serious threat to the wellbeing of people in Mackay and to Australia's wider population. As well as an increase in heat-related deaths and illness, the rise in extreme heat increases irritability and psychological stress.[10] Hot weather affects patterns in domestic violence,[11] interrupts sleep patterns and reduces capacity and willingness to exercise. All carry broad ramifications, such as increased accident risk, sedentary life style-induced diabetes and cardio vascular disease.[12] Tracking and minimising the way climate change is affecting the number of hot days is of direct interest to the wellbeing of local communities, particularly in areas of high vulnerability to heatwaves like Mackay.

[9] BoM (2019) *Daily Weather Observations*, http://www.bom.gov.au/climate/dwo/201802/html/IDCJDW4078.201802.shtml

[10] Queensland Health (2015) *Heatwave Response Plan* https://www.health.qld.gov.au/__data/assets/pdf_file/0032/628268/heatwave-response-plan.pdf

[11] Auliciems and Di Bartolo (1995) *Domestic violence in a subtropical environment: police calls and weather in Brisbane.* International Journal of Biometeorology 39 (1).

[12] Kjellstrom T et al (2009) *The Direct Impact of Climate Change on Regional Labor Productivity.* Archives of Environmental & Occupational Health 64 (4); World Health Organisation (2017) *Preventing noncommunicable diseases (NCDs) by reducing environmental risk factors*, http://apps.who.int/iris/bitstream/10665/258796/1/WHO-FWC-EPE-17.01-eng.pdf?ua=1

MACKAY

CSIRO and the Bureau of Meteorology (BoM) have produced temperature projections under several climate change scenarios for most of terrestrial Australia. The CSIRO–BoM data is a time series from the Australian Water Availability Project (AWAP) where the average temperature was compiled in roughly five kilometre by five kilometre spatial grids between 1981 and 2010.[13] This time series uses between five and eight models to predict days over 35 degrees, over 37 degrees and over 40 degrees in 2030, 2050, 2070 and 2090.[14] It also has a historical average for the years 1981–2010.

The report also employs the IPCC scenarios for global climate action: RCP 2.6 ("low emissions"), RCP 4.5 ("intermediate emissions") and RCP 8.5 ("high emissions/current government policies"). RCP 2.6 equates roughly to what is required to keep the world below 1.5 degrees warming, RCP 4.5 to what is required to keep the world below 2 degrees warming, and RCP 8.5 is the "business as usual" scenario where the world fails to act decisively on climate change. RCP 8.5 is the current trajectory due to the failure of most major polluting governments to implement necessary climate policies.

Mackay crosses one square of the spatial grid, encompassing both the CBD, West, and North Mackay.

Separately, the Bureau of Meteorology has three measurement stations in Mackay, the most reliable and long-standing being Mackay M.O. This station, though most reliable, is on a beach in North Mackay and so has lower average temperatures than those gathered from the two other stations.

ABOUT HEATWATCH

The Australia Institute's HeatWatch initiative puts current Australian research about temperature increases due to global warming into context, using data from the Bureau of Meteorology and the CSIRO.

Global temperature increases of 1.5 or 2 degrees above pre-industrial levels will have dramatic impacts on human health, the ecosystem and the economy. The IPCC has

[13] CSIRO and Bureau of Meteorology (2015) *Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report*, CSIRO and Bureau of Meteorology.

[14] All eight models – ACCESS1.0, CESM1-CAM5, CNRM-CM5, GFDL-ESM2M, HadGEM2-CC, CanESM2, MIROC5 and NorESM1-M – are available for the RCP 4.5 and RCP 8.5 scenarios. Five models – CESM1-CAM5, CNRM-CM5, CanESM2, MIROC5 and NorESM1-M – are available for the RCP 2.6 scenario.

found that human-induced warming reached 1 degree above pre-industrial levels in 2017.[15]

Current policy settings would see more extreme warming than 2 degrees above pre-industrial levels. However, temperatures fluctuate by much more than a few degrees every day, meaning that the compounding and extreme effects of temperature increases can be difficult to imagine.

HeatWatch uses extreme heat days (days over 35 degrees) along with other thresholds like 37 degrees and 40 degrees to highlight that the effects of global warming will include a dramatic increase in days where it is uncomfortable or dangerous to operate outside – affecting industries like construction, sport and other outdoor activities.

HeatWatch began with *Cooked with gas: Extreme heat in Darwin,* which highlighted that the Northern Territory's plans to exploit emission-intensive oil and gas reserves will contribute to global warming which could increase the number of days over 35 degrees in Darwin from the current rate of 22 per year to 275 per year in 2070.[16]

Other HeatWatch reports have covered extreme heat in Rockhampton, Gladstone, Roma, the Sunshine Coast, the Gold Coast, Western Sydney and Adelaide. Three Queensland reports were presented alongside Queensland Fire and Emergency Services workshops on extreme heat.

The Australia Institute will continue to focus on additional locations and welcomes interest in collaborating on local versions of the reports.

All HeatWatch reports are available on our website: http://www.tai.org.au/heatwatch

[15] IPCC (2018) *Global Warming of 1.5 °C,* p 1:4, https://www.ipcc.ch/report/sr15/

[16] Hanna and Ogge (2018) *Cooked with gas: Extreme heat in Darwin,* http://www.tai.org.au/content/cooked-gas-extreme-heat-darwin

Increasing hot days in Mackay

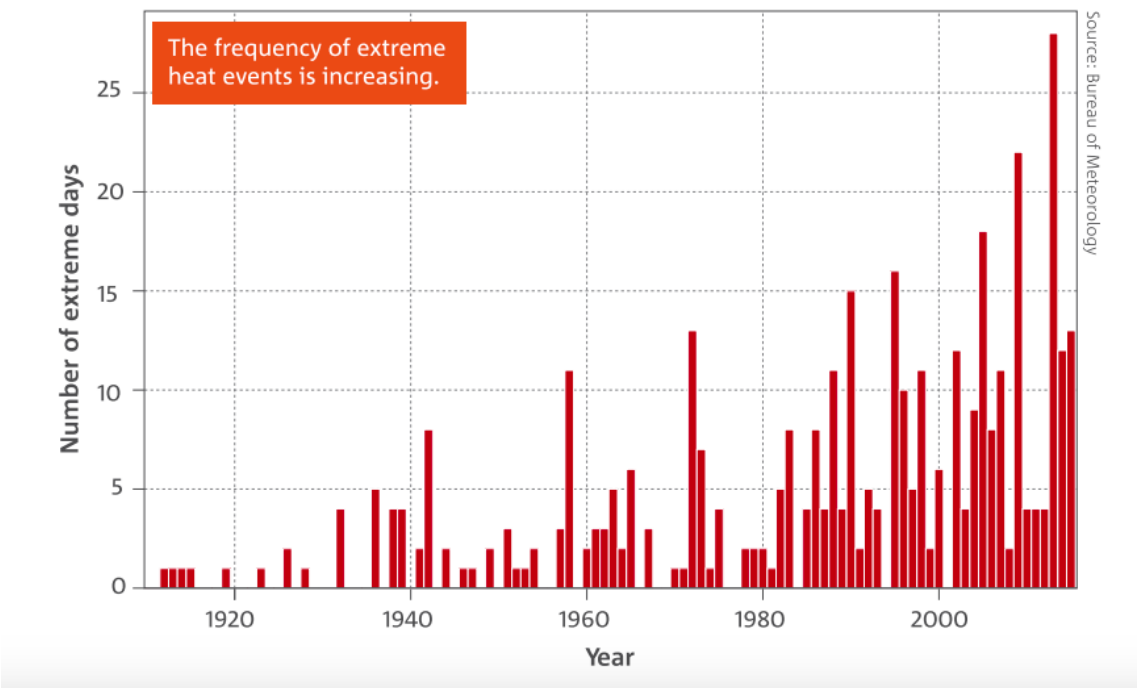
In Australia and globally there has been a clear trend of increasing temperatures and extreme heat events that are attributable to global warming.

The increase in extreme heat events across Australia as a whole is shown in Figure 3 below. This Bureau of Meteorology graph shows the annual number of days exceeding the 99th percentile of each month from 1910–2015.

The Bureau of Meteorology attributes this trend to global warming:

> As the global climate system has warmed, changes have occurred to both the frequency and severity of extreme weather. In Australia, the most obvious change has been an increase in the occurrence of record-breaking heat.[17]

Figure 3: Frequency of extreme heat days, Australia



Source: BoM (2016) *State of the Climate*

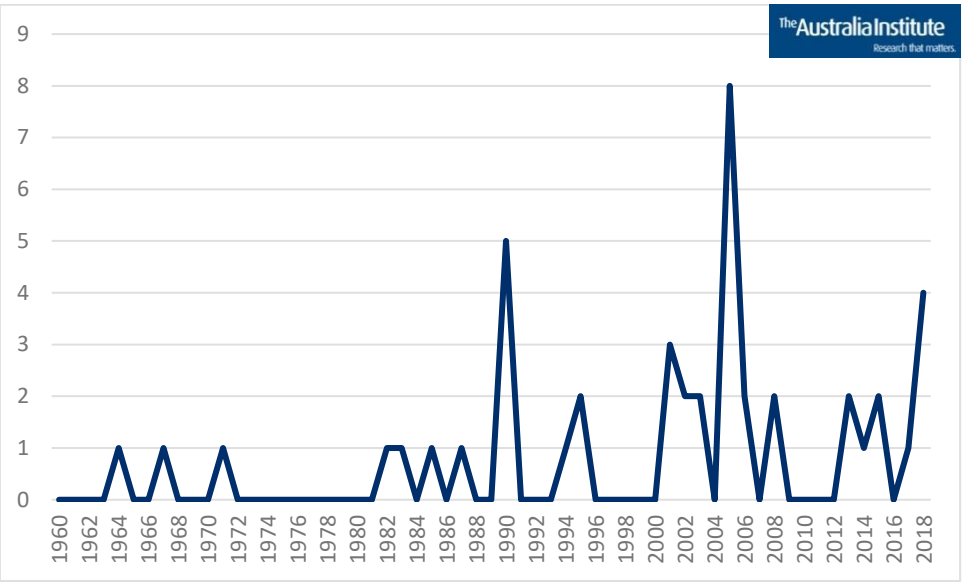
The Bureau of Meteorology has current temperature records for three sites in Mackay, two which have long term records: Mackay Airport (since 1951) and Mackay M.O

[17] BoM (2016) *State of the Climate*, http://www.bom.gov.au/state-of-the-climate/State-of-the-Climate-2016.pdf

(since 1960). This report will use the figures from Mackay M.O as the only site that holds records every year.

Figure 4 below shows the number of days over 35 degrees in each year from 1960 onwards at Mackay M.O.

Figure 4: Annual number of days over 35 degrees Mackay, 1960–2018



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml

Figure 4 shows that the trend of days over 35 degrees in Mackay has increased since 2000. Despite drought and heatwaves being common in Queensland, they have usually not affected Mackay. This trend has been changing over recent years.

There is a clear increase in numbers of extreme heat days over the recorded period as summarised in Table 1 below:

Table 1: Average days per year above 35 degrees, Mackay

Decade	Mackay M.O
1960–1969	0.2
1970–1979	0.1
1980–1989	0.4
1990–1999	0.8
2000–2009	1.9
2010–2018	1.1

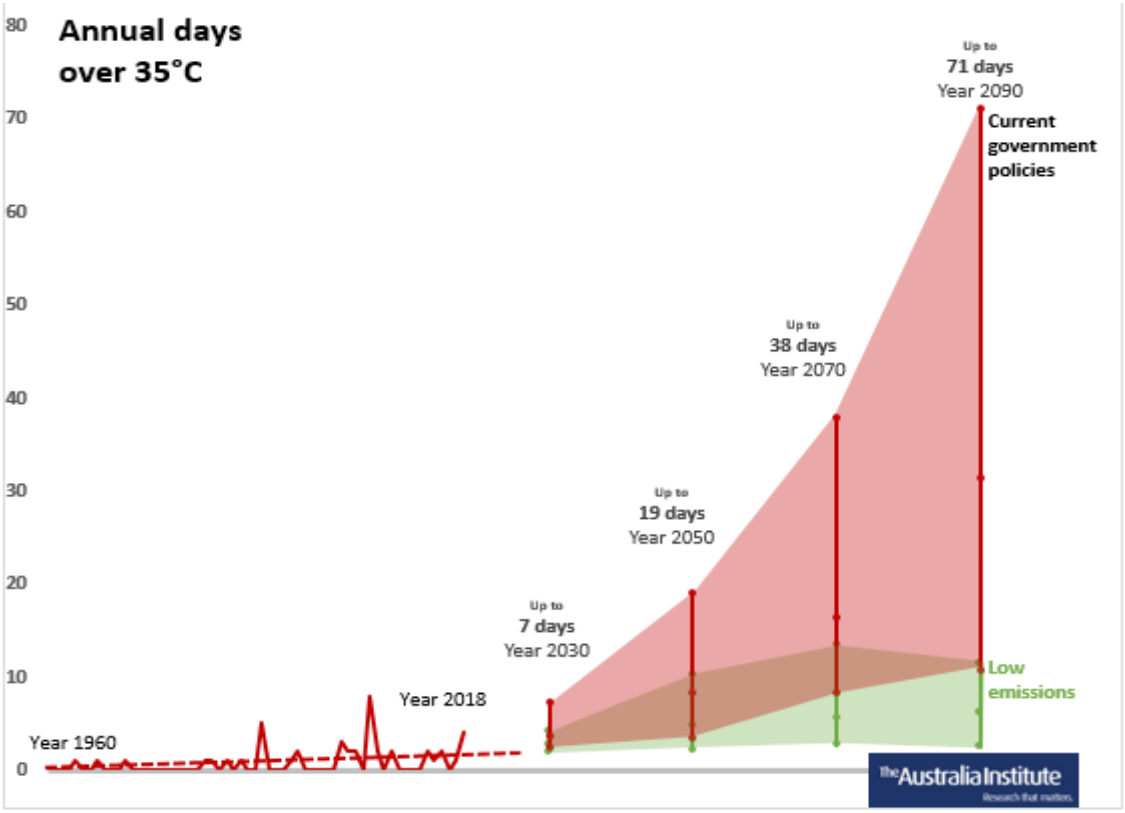
Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml

Projected increases in days over 35 degrees

Under current government policies, in Mackay days over 35 degrees would go from a historical average of 1.5 days per year to a maximum of 7 days by 2030, 19 days by 2050, 38 days by 2070 and 71 days by 2090. This would be concentrated in summer, where a maximum of 57% of summer days would be over 35 degrees by 2090.

Mackay would benefit significantly from climate policies that would keep warming below 1.5 degrees, as represented by the RCP 2.6 scenario. Climate policies to keep warming below 1.5 degrees would keep predicted days over 35 degrees to 2 days by 2030, increase to 10 days by 2050 and stabilise at 11 days by 2090.

Figure 5: Forecast annual number of days over 35 degrees Mackay



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Table 2: Mackay projected days over 35 degrees

	1981-2010	2030	2050	2070	2090
Historical	1.5				
Low emissions		2.0-4.3	2.2-10.1	2.7-13.5	2.4-11.4
Intermediate emissions		2.1-5.7	3.0-10.3	3.3-13.3	3.5-13.8
Current policies		2.4-7.3	3.5-19.0	8.2-38.0	10.7-71.2

Source: CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Urban Heat Island effect in Mackay

Highly urbanised areas create an environment that is divergent from the surrounding rural areas. Research has found that due to urban structures like concrete and skyscrapers - along with roads, pavement, and diminished vegetation cover – cities becomes warmer as more heat is absorbed in the materials during day and then released at night, which increases night-time temperatures.[18]

This creates an Urban Heat Island effect (UHI) not just on these surfaces but also in the atmosphere. This is more prominent during summer as temperatures rise. During the daytime UHI causes exposed surfaces like roofs to heat to temperatures up to 50 degrees hotter than the air while rural areas remain closer to the atmospheric temperatures, creating an 'island' effect in cities.[19]

It is at night though when UHI has its most negative influence on atmospheric heat extremes. Heat absorbed in urban structures during the day is slowly released after sunset compared to heat in vegetated areas. This produces much higher temperature shifts in the air overnight than in equivalent rural areas.[20] On a clear calm night, the US Environmental Protection Agency states that the temperature difference can be as high as 12 degrees between urban and rural areas.[21]

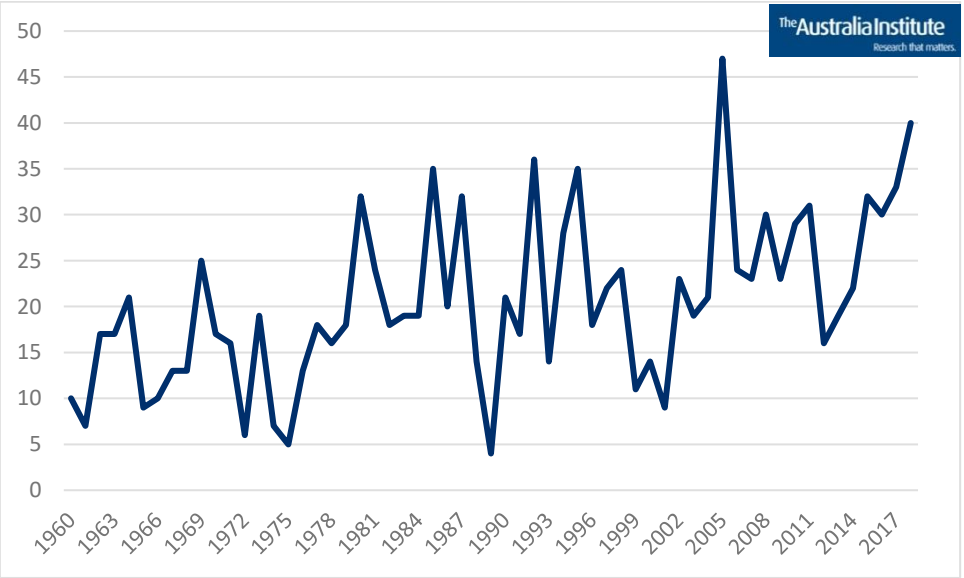
The overnight effects of UHI are consistent across climate zones and scenarios. Coastal cities like Mackay also suffer from UHI despite sea breeze.[22] Studies also raise the concern that night temperature extremes carry the higher risks of mortality as people are unable to recover from daytime heat stress.[23]

[18] Sharifi and Soltani (2017) *Daily variation of urban heat island effect and its correlations to urban greenery: A case study of Adelaide,* Frontiers of Architectural Research 6.
[19] United States Environmental Protection Agency, *Learn About Heat Islands,* https://www.epa.gov/heat-islands/learn-about-heat-islands
[20] Argueso et al. (2015) *Effects of City Expansion on Heat Stress under Climate Change Conditions,* PLoS ONE 10.
[21] United States Environmental Protection Agency, *Learn About Heat Islands,* https://www.epa.gov/heat-islands/learn-about-heat-islands
[22] Santamouris et al. (2017) *Urban Heat Island and Overheating Characteristics in Sydney, Australia – an analysis of multiyear measurements,* Sustainability 9.
[23] Zhao et al. (2018) *Interactions between urban heat islands and heat waves,* Environmental Research Letters 13.

Projected increases in nights over 25 degrees

The number of hot days in Mackay will be accompanied by an even greater increase in the frequency of extreme summer nights. Part of this more rapid warming at night is characteristic of the climate system however, as night-time temperatures are more sensitive to a build-up of greenhouse gases.[24] The BoM classifies nights with extreme heat as those with a minimum temperature of 25 degrees. As shown in Figure 6 below, this has already begun to occur:

Figure 6: Annual number of nights over 25 degrees Mackay, 1960–2018



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml

There is a clear increase in numbers of extreme heat nights over the recorded period, doubling from the 1960s, as summarised in Table 3 below:

[24] Davy et al. (2016) *Diurnal asymmetry to the observed global warming*. *International Journal of Climatology*.

Table 3: Average nights per year above 25 degrees, Mackay

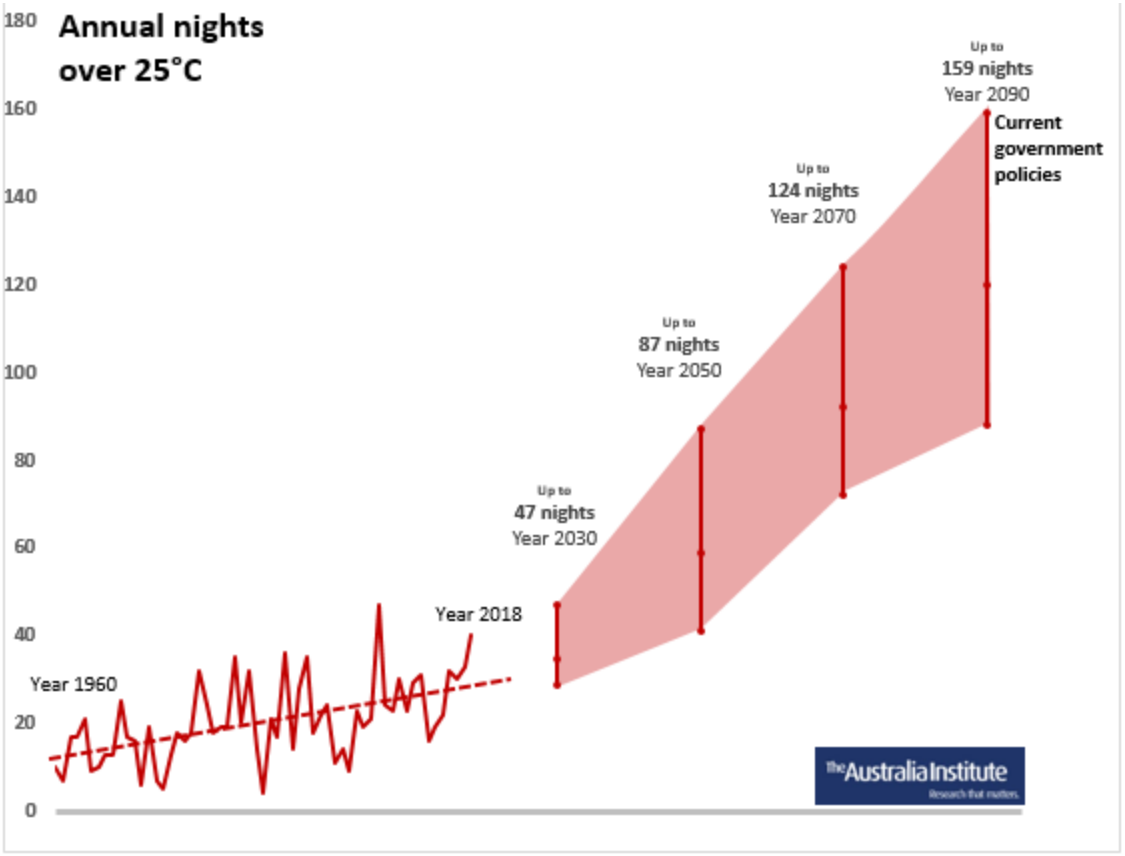
Decade	Mackay M.O
1960–1969	14.2
1970–1979	13.5
1980–1989	21.7
1990–1999	22.6
2000–2009	23.3
2010–2018	28.0

Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml

Under current government policies, in Mackay nights over 25 degrees would go from a historical average of 14.3 nights per year to a maximum of 47 nights by 2030, 87 nights

by 2050, 124 nights by 2070 and 159 nights by 2090. This would also be concentrated in summer, where a maximum of 95% of summer nights would be over 25 degrees by 2090. Figures for nights over 25 degrees under RCP 2.6 scenarios were not available at this time.

Figure 7: Forecast annual number of nights over 25 degrees Mackay



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2019) *Climate projections,* https://www.climatechangeinaustralia.gov.au/en/climate-projections/explore-data/threshold-calculator/

Health and productivity impacts of extreme heat

The impact of extreme heat on human health, particularly over extended periods, is severe. Although people living in hot areas do acclimatise to help cope with extreme temperatures, there are limits.[25] A large increase in days over 35 degrees will push past those limits.

The health impacts of increasing extreme heat can include both direct heat illnesses such as heat exhaustion and indirect illnesses such as heart failure and even death.

WorkSafe Queensland lists a range of illnesses arising directly from extreme temperatures from mild cramps, rashes, and dehydration to severe injuries such as heat stroke, exhaustion and even death if treatment is delayed.[26] As climate change worsens this can be expected to put people that are more vulnerable at increasingly greater risk.

The groups most vulnerable to heat impacts include the elderly, the very young, and those with pre-existing health conditions. Illnesses such as angina, kidney disease, and diabetes are at higher risk of being triggered or exacerbated when people are unable to maintain a safe body temperature.[27]

People suffering from mental disorders are also vulnerable. This vulnerability to extreme heat can result from altered behavioral responses to high temperatures or the impact of medications.

As stated earlier, irritability and psychological stress also increase in heat. When hot days are combined with hot nights, heat load and stress carry over and the body has no opportunity to cool down and recover. Studies show that there is an association between the mortality of not just stroke patients but also the general population and

[25] Hanna and Tait (2015) *Limitations to thermoregulation and acclimatisation challenges human adaptation to global warming,* Int J Environ Res Public Health 12.

[26] WorkSafe Queensland (n.d.) *Health effects,* https://www.worksafe.qld.gov.au/injury-prevention-safety/hazardous-exposures/heat-stress/health-effects

[27] Hanna et al (2016) *The silent killer: Climate Change and the Health Impacts of Extreme Heat,* The Climate Council, https://research-management.mq.edu.au/ws/portalfiles/portal/72578140/72578105.pdf

high night temperatures.[28] The 'synergistic effect' of night humidity, increased temperatures, and urban heat island effects in heatwaves has been estimated in some studies to double general mortality risk by the end of the century under RCP 8.5.[29] Often underrated, major heatwaves have been dubbed the 'silent killer', causing more deaths in the last century in Australia than all natural disasters put together.[30]

Extreme heat nights also cause increased insomnia and lack of rest. This is exacerbated by the higher relative humidity overnight. As sleep is vital for healthy human functioning, a deficit means more susceptibility to disease, obesity, chronic illness and harm to our psychological and cognitive functioning.[31]

Productivity decreases significantly under these stresses as people are affected with the consequences of extreme heat. Workplace safety and the ability to work declines. This can also be displayed in economic terms as costs rise to account for the lack of labour productivity and changes needed in workplaces.[32]

Like most parts of Australia, a significant proportion of the local workforce is exposed to the heat.

Construction and manufacturing are also both significant employers in Queensland and are particularly exposed to extreme heat events.

The cost of lost productivity because of extreme heat in Australia has been estimated at almost $7 billon in 2013-14 alone.[33]

[28] Murage et al (2017) *Effect of night-time temperatures on cause and age-specific mortality in London,* Environmental Epidemiology 1; Roye (2017) *The effects of hot nights on mortality in Barcelona, Spain,* International Journal of Biometeorology 61.

[29] Zhao et al (2018) *Interactions between urban heat islands and heat waves,* Environmental Research Letters 13.

[30] Hanna et al (2016) *The silent killer: Climate Change and the Health Impacts of Extreme Heat,* The Climate Council

[31] Obradovich et al (2017) *Nighttime temperature and human sleep loss in a changing climate,* Science Advances 3.

[32] Climate Council (2014) *Heatwaves: Hotter, Longer, More Often,* https://www.climatecouncil.org.au/uploads/9901f6614a2cac7b2b888f55b4dff9cc.pdf

[33] Zander, Opperman and Garnet (2015) *Extreme heat poses a billion-dollar threat to Australia's economy,* https://theconversation.com/extreme-heat-poses-a-billion-dollar-threat-to-australias-economy-41153

HEAT STRESS AND THE MACKAY WORKFORCE

Increasing extreme heat will have serious consequences for the health and safety of many of Mackay's workforce.

The workforce in Mackay is particularly vulnerable to the dangers of increasing extreme heat with around 25 per cent of the workforce employed in the mining, construction and agricultural industries, all of which require workers to undertake heavy work in the heat.[34]

As discussed above, at temperatures above 35 degrees, the human body's main cooling mechanism – sweating – is far less effective. Sweating exchanges heat from the body to the atmosphere, but this heat exchange process diminishes significantly beyond 35 degrees, so body temperature rises. There is a range of health impacts, from mild to severe. Heat stroke can cause permanent damage to the brain and other vital organs and can even result in death.[35]

> When environmental temperatures exceed that of dry skin, sweating becomes the primary source of thermoregulation. However, as temperatures continue to rise, particularly in humid environments with poor airflow, this may not be enough. The body's core temperature rises, resulting in a continuum of ailments, collectively known as heat illness. This ranges from the relatively mild heat rash and muscle cramps, to heat exhaustion and the potentially fatal heat stroke.
>
> Heat illness can present as headache, nausea or vomiting, irritability, clammy skin, dizziness, fatigue, elevated heart rate, and rapid breathing rate. This translates to lower productivity, poor morale and higher rates of accidents in the workplace. When left untreated, heat illness can progress to heat stroke, where confusion, further reduced muscle coordination, convulsions and ultimately a loss of consciousness can occur.[36]

[34] ABS (2016) *Table Builder 2016 Australian Census,* https://auth.censusdata.abs.gov.au/webapi/jsf/tableView/tableView.xhtml

[35] Hanna and Tait (2015) *Limitations to thermoregulation and acclimatisation challenges human adaptation to global warming,* Int J Environ Res Public Health, https://academic.oup.com/heapro/article/30/2/239/561863

Australian Mining Review (November 2017) WA miners urged to guard against heat stress, https://www.miningreview.com.au/wa-miners-urged-guard-heat-stress/

[36] Australasian Mining Safety Journal (October 2015), Handling the heat, https://www.amsj.com.au/handling-the-heat/

A survey of mine workers in Northern Australia found heat stress symptoms were experienced by 87 per cent of open cut mine workers and 79% of underground mine workers. These symptoms were experienced more than once by around 80% of workers. It also found that only 27% were well hydrated with 10% significantly dehydrated.[37]

There are also factors that compound the heat risks of mining in particular including having to wear heavy protective clothing that can reduce air circulation to the skin, long shifts and that water is not always readily available.

Despite Worksafe Queensland warnings that working in extreme heat can lead to serious injury and death,[38] there is no temperature level threshold for halting heavy outdoor work in Queensland. The death of a CSG worker near Roma in Queensland as a result of heat in 2016 prompted the Coroner to recommend on being adopted.[39]

[37] Hunt et al (2012) Symptoms of heat illness in surface mine workers, https://eprints.qut.edu.au/54048/

[38] WorkSafe Queensland (n.d.) *Health effects,* https://www.worksafe.qld.gov.au/injury-prevention-safety/hazardous-exposures/heat-stress/health-effects

[39] Briggs (2016) Coroner calls for temperature threshold to stop outdoor work in extreme heat, https://www.abc.net.au/news/2016-04-20/coroner-calls-temperature-threshold-to-stop-outdoor-work-heat/7342464

Infrastructure and industry

Extreme heat can cause failures to critical infrastructure, particularly transport and electricity supply. Coal and gas power stations in particular are highly vulnerable to extreme heat, experiencing both reduced output and an increased level of breakdowns. This is exacerbated by high electricity demand as a result increased use of air-conditioning during extreme heat conditions. During the February 2017 heatwave in South Australia, 17% of gas generation (438 MW) failed to deliver during the peak demand period on the heatwave day (8th of February),[40] leading to widespread blackouts.[41]

In an urbanised environment like Mackay, air-conditioning can be critical to people's wellbeing during extreme heat. Electricity blackouts during heatwaves lead to the loss of air-conditioning when it is most essential. During the 2009 Heatwave in Melbourne on the evening of the 30th of January, 500,000 people were left without power on a day that reached 44 degrees. There were 374 deaths recorded as a result of this heatwave overall. The estimated economic cost of the heatwave was $800 million.[42]

An efficient transport system is fundamental to the functioning of all large cities. Transport is also vulnerable to extreme heat. Roads can melt[43] and rail can buckle.[44]

Some public transport does not have air-conditioning, or the air-conditioning can break down, causing great distress to commuters.[45]

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[40] Ogge and Aulby (2017) *Can't stand the heat; The energy security risk of Australia's reliance on coal and gas generators in an era of increasing heatwaves*, http://www.tai.org.au/sites/defualt/files/P454%20Can%27t%20stand%20the%20heat%20FINAL%202.31.pdf

[41] Harvey and Shepherd (February 2017) *Rolling blackouts ordered as Adelaide swelters in heatwave,* https://www.news.com.au/national/south-australia/rolling-blackouts-ordered-as-adelaide-swelters-in-heatwave/news-story/13394f19db1ee94a59f4036fccdc1ba7

[42] NCCARF (2010) *Impacts and adaptation responses of infrastructure communities to heatwaves,* https://www.nccarf.edu.au/business/sites/www.nccarf.edu.au.business/files/attached_files_publications/Pub%2013_10%20Southern%20Cities%20Heatwaves%20-%20Complete%20Findings.pdf

[43] Cheer (January 2018) *Traffic delays after 10 kilometers of Victoria's Hume Freeway melts,* https://www.sbs.com.au/news/traffic-delays-after-10-kilometres-of-victoria-s-hume-freeway-melts

[44] Lauder (2009) *Melbourne railway buckles under heat,* http://www.abc.net.au/worldtoday/content/2008/s2477350.htm

[45] Robertson (January 2017) *Eastern Australia swelters under heatwave as hottest January on record looms,* https://www.theguardian.com/australia-news/2017/jan/18/eastern-australia-swelters-under-heatwave-as-hottest-january-on-record-looms

Conclusion

An increase in days of temperature over 35 degrees will have severe impacts on human health, including increased rates of heat-related deaths.

Mackay is now experiencing an increase in extreme heat events, affecting people's ability to work and enjoy the outdoors, to play and watch sport. Mackay is disproportionately affected by the heat due to its location in North Queensland and the exposure of its workforce to heat stress.

Fortunately, none of this this inevitable. The CSIRO projections clearly show that if emissions are reduced in line with the Paris target of limiting global temperature increases to below 1.5 degrees, the increase in extreme temperature days will be a small fraction of the increase projected for our current emissions trajectory.

Australia makes a vastly disproportionate contribution to global warming. We are one of the lowest ranked countries in the world on climate action. As well as having one of the highest rates of domestic greenhouse gas emissions per person in the world, we have a staggering 44 tonnes per person of exported greenhouse gas emissions each, even greater then Saudi Arabia (35.5 tonnes per person) and around sixty times higher than the US.[46] Even worse, there are plans for huge expansions in gas exports from the Northern Territory and Western Australia that could add a billion tonnes more of greenhouse gases to the atmosphere.[47]

Stopping any further expansion of Australia's coal and gas exports, greadually phasing out existing exports and reducing emissions produced at home are all essential to the global effort required to prevent increases in extreme heat that will have such a devastating effect on Mackay and Australia as a whole.

[46] Thwaites and Kestin (July 2018) *Australia ranked worst in world on climate action,* https://reneweconomy.com.au/australia-ranked-worst-world-climate-action-49472/

[47] Climate Analytics (2018) *Western Australia's gas gamble, Implications of exploiting Canning Basin and other unconventional gas resources for achieving climate targets,* https://climateanalytics.org/media/climateanalytics-report-westernaustraliasgasgamble-2018.pdf