CLIMATE COUNCIL

AGEING AND UNPREPARED: ENERGY IN NEW SOUTH WALES

CLIMATECOUNCIL.ORG.AU

Thank you for supporting the Climate Council.

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

We would like to thank the Australian Communities Foundation for their support in producing this report.

Published by the Climate Council of Australia Limited

ISBN: 978-1-925573-87-9 (print)
978-1-925573-86-2 (digital)

Ageing and Unprepared: Energy in New South Wales.

Authors: Louis Brailsford, Annika Dean, Greg Bourne and Andrew Stock.

We would like to thank Tim Buckley (IEEFA) and David Leitch (ITK Services) for their thorough reviews.

This report is printed on 100% recycled paper.

facebook.com/climatecouncil
twitter.com/climatecouncil
info@climatecouncil.org.au
climatecouncil.org.au

Louis Brailsford
Researcher

Dr Annika Dean
Senior Researcher

Greg Bourne
Climate Councillor

Professor Andrew Stock
Climate Councillor

Contents

Key Findings ii

1. New South Wales - From a leader to a laggard 1
2. New South Wales once led the world in climate action 4
3. Today, New South Wales is a climate laggard, heavily reliant on polluting coal 7
4. Policies to tackle climate change in New South Wales are falling short 19
5. Climate impacts in New South Wales 24
6. Conclusion: New South Wales has some catching up to do 29

References 30

Image Credits 33

Key Findings

1

New South Wales was once a world leader on climate action, but over the past five years it has become a laggard.

- New South Wales introduced the world's first emissions trading scheme in 2003, which over 10 years reduced greenhouse gas pollution by an estimated 144 million tonnes. The scheme concluded in 2012.
- Over the past five years South Australia, the Australian Capital Territory and Tasmania have led the country on renewable energy progress, while New South Wales has consistently remained at the back of the pack.
- New South Wales used to have strong emissions reduction targets to reduce greenhouse gas pollution but these targets were dropped; the state planned to introduce a renewable energy target, but it was never implemented.

2

New South Wales is responsible for more greenhouse gas pollution than any other state or territory and continues to rely on heavily polluting coal and unreliable gas power stations.

- New South Wales has Australia's oldest coal fleet and is home to five operating coal power stations; collectively they produced 82% of the state's electricity in 2017.
- It is risky to rely on old coal power stations because they become increasingly unreliable with age.
- New South Wales has excellent wind and solar resources; however, they account for just 6% of the electricity generated in New South Wales.

3

Current climate policies in New South Wales are inadequate, although local councils are stepping up in the face of state government inaction.

- New South Wales does not have a comprehensive policy or target to encourage new renewable energy generation, nor does it have policies to enable the state to reach its net zero emissions target in 2050.
- In the past 12 months the state has taken some positive steps to encourage renewable energy and storage technologies, further action is required.
- There is massive potential in New South Wales for new jobs and investment in a renewable energy future.
- Local councils like Lismore, Newcastle and Musswellbrook are all leaders on climate action.

4

New South Wales is highly exposed to the impacts of climate change.

- Climate change, driven by the burning of coal, oil and gas, is already affecting New South Wales.
- Extreme heatwaves led to a 10% increase in both deaths and ambulance callouts in New South Wales between 2005 and 2015.
- Damages from extreme weather events cost New South Wales $3.6 billion per year and this figure is likely to rise as these events, driven by climate change, become more frequent and severe.
- The cheapest and fastest way for New South Wales to reduce its greenhouse gas pollution would be to progressively replace the state's coal power stations with renewable energy like wind and solar, with storage.

1. New South Wales - From a leader to a laggard

Over a decade ago, the state of New South Wales had world-leading climate policies. In 2003 New South Wales introduced the world's first emissions trading scheme - the Greenhouse Gas Abatement Scheme – along with mandatory emissions reduction targets (IPART 2013). These policies were later replaced by Australia's national Carbon Pricing Mechanism when it commenced operation in 2012.

Over the past five years, the Climate Council has been tracking the renewable energy progress of Australia's states and territories. Some states and territories, like Tasmania and South Australia have led the pack over this period, or even the world in the case of South Australia. Others, like Victoria and Queensland, have been catching up. New South Wales has remained consistently at the back of the pack, practically standing still as the majority of states and territories raced ahead (Climate Council 2018a).

New South Wales has fantastic renewable energy resources (Department of Planning and Environment 2018). Private investors have recognised this, with New South Wales home to a range of large-scale wind and solar farms, including the Griffith solar farm and the Silverton wind farm (Clean Energy Regulator 2018b). In 2018, eight new wind and solar farms began operating (Clean Energy Regulator 2018b). Most of these new wind and solar projects have been built as part of the Federal Government's renewable energy target, which is expected to be met by 2020. Other projects like the Crookwell 2 wind farm were contracted under the Australian Capital Territory Government's 100% renewable energy target (ACT Government 2016).

New South Wales was once a world leader on climate action.

The New South Wales public is very supportive of renewable energy, with 83% wanting the state to generate more of its electricity with renewable energy (New South Wales Government 2015). Local government is also backing renewable energy, with more than twenty local councils supporting new solar farms in the state to help reduce their power bills (refer to Figure 1).

However, despite recent renewable energy investment, New South Wales risks being left behind the other states and territories.

New South Wales is home to Australia's oldest fleet of coal power stations and has limited state government policies to encourage more wind and solar projects in the state beyond 2020. There is a serious risk that New South Wales will be caught short as coal power stations close or unexpectedly fail in extreme weather events.

Figure 1: The 100kW Lismore floating solar farm, the largest to-date in Australia. Lismore City Council and other councils in New South Wales are backing renewable energy to help reduce their power bills and greenhouse gas pollution.

New South Wales has remained at the back of the pack for action on renewable energy over the past five years.

New South Wales is highly exposed to the impacts of climate change. Rising greenhouse gas pollution, primarily from the burning of fossil fuels like coal and gas, is driving up global temperatures and worsening extreme weather events. In recent decades there has been an increase in extreme fire weather and a lengthening of the bushfire season across New South Wales (CSIRO and BoM 2018). Heatwaves have increased in duration, frequency and intensity in parts of New South Wales (Climate Council 2017; OEH 2015).

Extreme heatwaves have already led to a 10% increase in both deaths and ambulance callouts in New South Wales between 2005 and 2015 (Jegasothy et al. 2017). By 2030, maximum temperatures are expected to rise by 0.7°C in New South Wales and continue to rise by 2.1°C by 2070 (compared to the baseline modelled climate between 1990 and 2009) (NARCliM 2019). The impact of climate change will become even more intense in coming decades if greenhouse gas pollution is not reduced.

State and territory leadership will continue to be critical to supporting investment in new large-scale wind, solar and storage projects in Australia. This is particularly important in the absence of any credible national climate and energy policy to succeed the Renewable Energy Target from 2020. New South Wales has an opportunity to catch up with other states and territories but this would require strong action. Otherwise New South Wales could largely forfeit this opportunity to Victoria, Queensland and South Australia, missing out on the associated employment and investment opportunities in the state.

This report begins by reflecting on New South Wales' past climate leadership in the 2000s before taking stock of the current situation. In 2019 after almost a decade of stagnation, New South Wales has an electricity sector still dominated by ageing coal power stations and unreliable gas power stations while wind and solar make up a relatively small proportion of power generation.

The report then outlines current policies in place to encourage investment in energy storage and new transmission in New South Wales.

The next section outlines the vulnerability of New South Wales to climate change and the climate impacts the state may face if greenhouse gas pollution is not reduced. The report concludes by encouraging New South Wales to rise to the challenge and lead with strong policies to tackle climate change and scale-up renewable energy once again.

2. New South Wales once led the world in climate action

In 2003, New South Wales led the world by introducing the first mandatory emissions trading scheme in the world – the Greenhouse Gas Reduction Scheme (IPART 2013).

Under this policy, mandatory emissions abatement targets were set and certificates were available for activities such as renewable energy generation, reduced emissions from existing generators and large energy consumers, carbon sequestration or improved energy efficiency (IPART 2013).

After operating for nearly a decade, the Greenhouse Gas Reduction Scheme was closed in 2012 when Australia's national Carbon Pricing Mechanism commenced operation. However, no new carbon pricing initiatives have been proposed in New South Wales since the Carbon Pricing Mechanism was revoked. Over its ten years of operation, it is estimated the state's Greenhouse Gas Reduction Scheme prevented around 144 million tonnes of carbon dioxide from being emitted. Overall compliance with the scheme by electricity producers and consumers was very high (IPART 2013).

New South Wales introduced the world's first emissions trading scheme in 2003.

New South Wales used to have strong emissions reduction targets but these were dropped; it also planned to introduce a renewable energy target, but it was never implemented.

The New South Wales state government also set targets to reduce greenhouse gas pollution to 2000 levels by 2025 and 60% below 2000 levels by 2050 (New South Wales Government 2006). In 2010, these emissions reduction targets were removed in the process of drafting the new State Plan NSW 2021 (ABC 2010; New South Wales Government 2011).

In 2006, the New South Wales Government also planned to introduce a state-wide renewable energy target requiring 10% of electricity consumed in the state to be generated by renewable energy by 2010 and 15% by 2020 (New South Wales Government 2006). This target was not implemented, as the Federal Government in 2009 extended the national Renewable Energy Target to 2020 and increased the target to 41,000GWh of renewable electricity (from large-scale renewable energy, with the aim of achieving at least 20% renewable energy; Clean Energy Regulator 2016). In May 2015 this federal target was scaled back to 33,000GWh by 2020.

BOX 1: THE PEOPLE OF NEW SOUTH WALES SUPPORT RENEWABLE ENERGY

Four in every five people in New South Wales think the state should use more renewable energy, like wind and solar.

In 2015, the News South Wales Government's Office of Environment and Heritage released the results of a survey on community attitudes to renewable energy in the state. The survey found that 91% of the 2,000 survey participants support the use of renewable energy to generate electricity in New South Wales. 83% of people surveyed stated that New South Wales should be producing more electricity from renewable energy, compared to just 3% who thought they should use less and 11% who supported maintaining current levels of renewable energy. Participants identified benefits to the environment (80%) and lower cost (37%) as the main advantages of renewable energy (New South Wales Government 2015). Since this survey was conducted, the cost of renewable energy has more than halved.

83% of people in New South Wales want the state to use more renewable energy.

Figure 2: The people of New South Wales support renewable energy and want to see the state produce more electricity from wind and solar, such as the Broken Hill solar farm.

3. Today, New South Wales is a climate laggard, heavily reliant on polluting coal

NEW SOUTH WALES' ELECTRICITY IS PREDOMINANTLY SUPPLIED FROM FOSSIL FUELS

New South Wales is Australia's most populous state and is responsible for more greenhouse gas pollution than any other state or territory (Department of the Environment and Energy 2018a).

In 2016, total emissions from New South Wales were 144 million tonnes of carbon dioxide, excluding land use emissions. Electricity generation produced 51.8 million tonnes of carbon dioxide or 36% of the state's emissions (Department of the Environment and Energy 2018a). While New South Wales' per capita emissions were lower than those of Western Australia, Queensland, Northern Territory and Victoria, per capita emissions were above South Australia, Tasmania and the Australian Capital Territory (Department of the Environment and Energy 2018a), all of whom have been renewable energy leaders under Climate Council metrics (refer to Box 4).

The cheapest and quickest way for New South Wales to reduce its greenhouse gas pollution would be to progressively replace the state's ageing coal power stations with renewable energy like wind and solar, with storage (BNEF 2018), complemented by the state's existing hydro generation.

New South Wales is responsible for more greenhouse gas pollution than any other state or territory.

NEW SOUTH WALES HAS AUSTRALIA'S OLDEST COAL FLEET

New South Wales is home to five operating coal power stations. These five power stations collectively produced 82% of New South Wales' electricity in 2017 (Department of the Environment and Energy 2018b). This means New South Wales generated a greater proportion of its electricity from coal than any other state in 2017 (refer to Table 1).

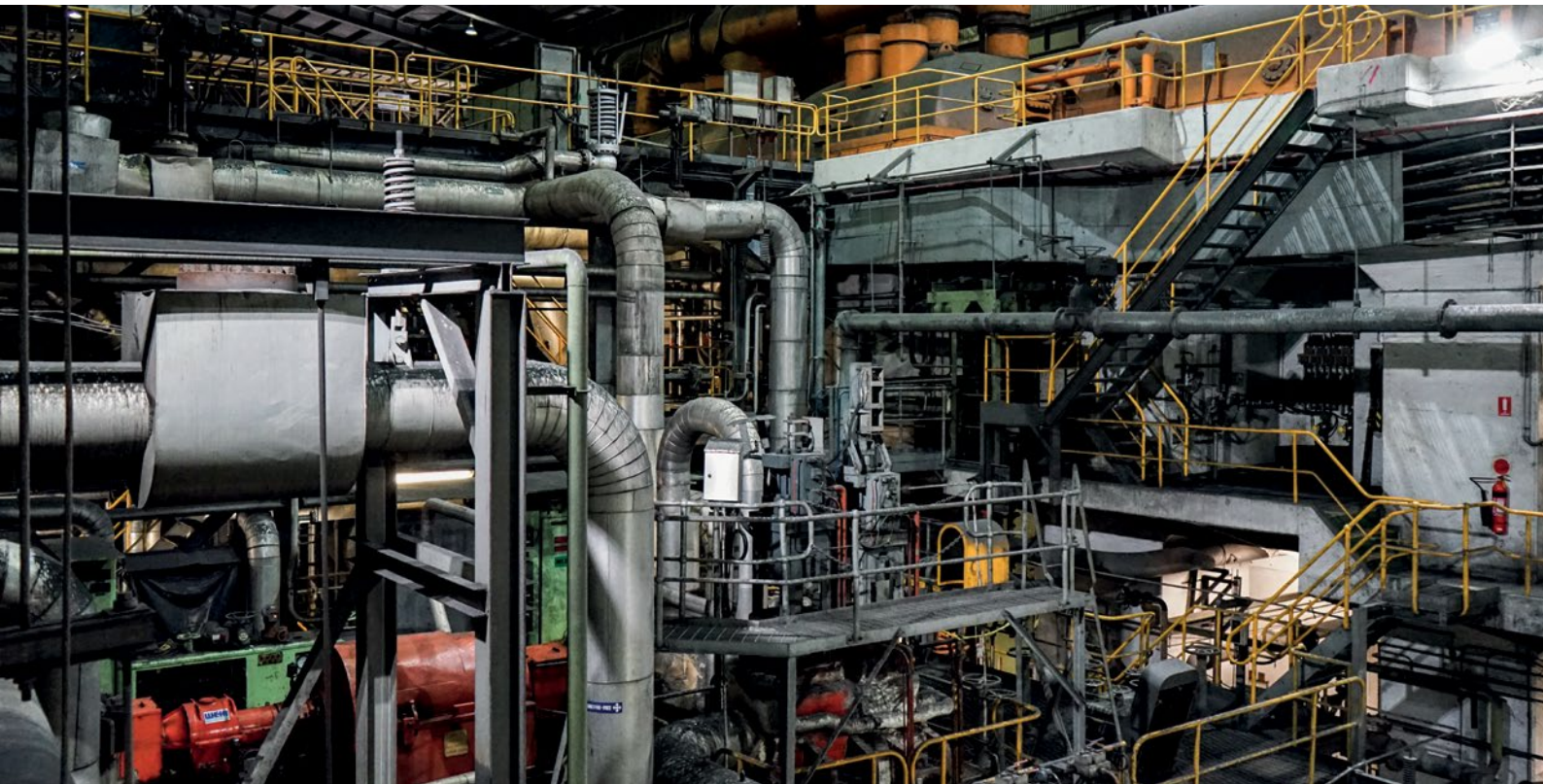
New South Wales also has some of Australia's oldest coal power stations. The state is home to four of Australia's six oldest coal power stations (AEMO 2018b; APH 2017). The Liddell coal power station is 47 years old and scheduled to close by 2022 (refer to Figure 3). Three other coal power stations – Vales Point, Eraring and Bayswater – are also due to close within the next 15 years (refer to Table 2; AEMO 2018b; APH 2017).

Table 1: New South Wales generated a greater proportion of its electricity from coal than any of Australia's other coal producing states in 2017.

State	Proportion of electricity generation from coal power stations in 2017
New South Wales	**82%**
Victoria	78%
Queensland	73%
Western Australia	27%

Source: Department of the Environment and Energy (2018b).

Figure 3: The Liddell power station (pictured) is the oldest coal power station in Australia. It is scheduled to close by 2022.



New South Wales has Australia's oldest fleet of coal power stations.

Relying on a fleet of very old coal power stations to power Australia's largest state is risky. Ageing coal power stations are increasingly unreliable and prone to breaking down in extreme weather events, especially heatwaves. Coal power stations are slow to respond to changes in supply and demand and struggle to quickly ramp up and down (AEMO 2017a). These power stations cannot be depended upon to provide a reliable supply of electricity. Extreme weather events will increase electricity supply risks. The New South Wales Chief Scientist found that the ageing coal fired power station fleet in New South Wales "poses risks to reliability and security across the NEM..." (NSW Chief Scientist & Engineer 2017).

Coal power stations are already breaking down in warmer months. The Eraring, Bayswater and Liddell power stations all broke down at least once between December 2018 and February 2019, with the Eraring power station breaking down three times. (The Australia Institute 2019).

Table 2: New South Wales has five operating coal power stations. Four of these power stations are approaching the end of their life as they become increasingly unreliable and unsafe to operate after 40 years of operation, increasingly prone to unexpected failure.

Power Station	Capacity (megawatt (MW))	Age in 2019[1]	Capacity Factor (2016-17)	Emissions Intensity (2016-17) (t CO_2-e/MWh)
Liddell	1,680[2]	47	49%	0.93
Vales Point	1,320	41	59%	0.85
Eraring	2,880	37	57%	0.86
Bayswater	2,640	37	56%	0.89
Mt Piper	1,400	26	53%	0.87

[1] Where units at power stations were commissioned over several years, the age of the oldest unit has been listed.
[2] Originally rated at 2,000MW, the Liddell power station has been de-rated to an effective capacity of 1,680MW due to its old age.

Source: APH (2017); Clean Energy Regulator (2018a); McConnell (2018).

Figure 4: New South Wales has five operating coal power stations, which supply 82% of New South Wales' electricity.

NEW SOUTH WALES' AGEING COAL CLUNKERS

#1 LIDDELL

Age	47
Capacity (MW)	1,680
Due to retire in[1]	2022
Breakdowns in 2018[2]	11

#2 VALES POINT

Age	41
Capacity (MW)	1,320
Due to retire in	2028
Breakdowns in 2018	4

#3 ERARING

Age	37
Capacity (MW)	2,880
Due to retire in	2032
Breakdowns in 2018	3

#4 BAYSWATER

Age	37
Capacity (MW)	2,640
Due to retire in	2032
Breakdowns in 2018	3

#5 MT PIPER

Age	26
Capacity (MW)	1,400
Due to retire in	2043
Breakdowns in 2018	1

END OF THE LINE

New South Wales has an ageing fleet of five coal power stations. Four are due to retire in the next fifteen years.

[1] Coal power stations reach the end of their design life after 50 years of operation. Coal power stations should be retired at this age.

[2] Breakdowns refer to 'unit trips', where a unit at a power station suddenly stops generating electricity.

BOX 2: HOW TO POWER INDUSTRY WITH RENEWABLE ENERGY: NEW SOUTH WALES VERSUS SOUTH AUSTRALIA

The Tomago Aluminium smelter is New South Wales' largest electricity consumer and reliant on unreliable coal power stations for electricity. Renewable energy and storage can provide the Tomago smelter and other large industrial users with a clean, affordable and reliable supply of electricity, as will be demonstrated by the steelmakers GFG Alliance in South Australia.

Due to its size, the Tomago Aluminium smelter occasionally has its electricity supply reduced when coal and gas power stations break down causing a shortage of electricity in the state. On 10 February 2017, during a period of very high electricity demand, the Australian Energy Market Operator (AEMO) reduced electricity supply to the Tomago smelter (AEMO 2017b). This was primarily due to problems at the state's coal and gas power stations. The Colongra gas power station was unable to start when requested by AEMO and the Tallawarra gas power station experienced a fault that meant it could not generate electricity when it was most needed (AEMO 2017b).

On another occasion in June 2018, the smelter shut down one of its potlines for an hour on two different days due to outages at the Liddell, Bayswater and Vales Point coal power stations (The Newcastle Herald 2018). Three of Bayswater's four units were not operating and the entire Vales Point power station was offline (refer to Figure 5; The Newcastle Herald 2018).

The Tomago smelter could reduce its reliance on unreliable coal and gas generation and dramatically reduce the carbon intensity of its electricity purchases by following the lead of GFG Alliance in South Australia and Sun Metals zinc refinery in Queensland, contracting for new renewable energy and storage investments (RenewEconomy 2018d).

In 2017, the GFG Alliance bought South Australia's Whyalla Steelworks and has since developed a plan to power the steelworks on renewable energy. GFG Alliance plans to increase the production capacity of the steelworks to 1.8 million tonnes and potentially 10 million tonnes in the future. The initial expansion of the steelworks is expected to cost $600 million and create 2,500 jobs (RenewEconomy 2018c). Underpinning this expansion is renewable energy and storage. Construction will begin this year on the 280MW Cultana solar farm, with investments in more solar, batteries and pumped hydro possible in the future (RenewEconomy 2018c).

Wind and solar are the cheapest sources of new energy generation and far cheaper than building a new coal power station (BNEF 2018). Coupled with storage, these technologies can cost effectively and securely power the significant energy requirements of heavy industry (ABC 2017).

Figure 5: The Vales Point coal power station. The power station is the second oldest in New South Wales and one of four coal power stations scheduled to close in the state by 2035.

NEW SOUTH WALES HAS AN UNRELIABLE GAS FLEET

New South Wales has four gas fired power stations and another small power station that runs on fuel oil (refer to Table 3). These gas and oil power stations produce significantly less electricity than coal, but New South Wales is heavily reliant on them to supply electricity during periods of very high electricity demand, such as hot summer evenings.

Three of New South Wales' gas power stations were built ten years ago. Even so, these power stations do not have a good track record of providing a reliable supply of electricity during heatwaves. The trebling of domestic gas prices this decade has also dramatically eroded the commercial viability of these gas fired power stations.

On 10 February 2017 during a period of very high electricity demand, AEMO reduced electricity supply to the Tomago Aluminium smelter in New South Wales as there was a shortage of electricity available to meet demand (refer to Box 2; AEMO 2017b). This was primarily due to problems at the state's coal and gas power stations. Gas power stations performed especially poorly. Snowy Hydro's Colongra gas power station, the largest in New South Wales, was unable to start when requested by AEMO and the Tallawarra gas power station experienced a fault that meant it could not generate electricity when it was most needed (AEMO 2017b).

Two gas power stations broke down or couldn't start in the February 2017 heatwave in New South Wales, leading to blackouts.

Table 3: New South Wales has four gas fired power stations and a small power station that runs on fuel oil. Although some of these power stations are just 10 years old, they have proven to be unreliable in heatwaves.

Power Stations	Fuel Type/Technology	Capacity (MW)	Age in 2019	Emissions Intensity (2016-17) (t CO_2-e/MWh)
Smithfield Energy Facility	Gas, combined cycle	171	23	0.47
Colongra	Gas, open cycle	724	10	0.66
Uranquinty	Gas, open cycle	664	10	0.61
Tallawarra	Gas, combined cycle	435	10	0.39
Hunter Valley Turbines	Fuel oil, open cycle	50	?	1.52

Source: AEMO (2018a); Clean Energy Regulator (2018a). Scheduled generation only.

NEW SOUTH WALES HAS A RELATIVELY LOW PROPORTION OF WIND AND SOLAR

New South Wales generated 16% of its electricity from renewable energy in 2016-17 (Department of the Environment and Energy 2018b). The bulk of the state's renewable energy comes from old hydro power stations, which provided almost 9% of the state's electricity in 2016-17. In contrast, wind and solar generated just 6% of New South Wales' electricity. The remainder was generated by biogas and biofuels (Department of the Environment and Energy 2018b).

Over the five-year period from 2011-12 to 2016-17, the share of wind and solar electricity generation increased by just 4% (refer to Table 4). This is a smaller increase than other states like South Australia (20%), Tasmania (8%) and Victoria (6%).

New South Wales has globally significant wind and solar resources of an excellent quality (Department of Planning and Environment 2018). Eight new renewable energy plants began operation in New South Wales in 2018, including five solar farms and three wind farms (refer to Table 5 and Figure 6; Clean Energy Regulator 2018b).

A further 20,000MW of renewable energy capacity has received or is awaiting planning approval from the state government (New South Wales Government 2018a). This is twice the capacity of the state's entire fleet of coal power stations. Ultimately many of these projects will never be built as 20,000MW is far more new capacity than New South Wales needs. In order for some of these projects to be built, there must be clear policies to encourage renewable energy and enable investment in new transmission and energy storage capacity.

Wind and solar generate just 6% of the electricity in New South Wales.

Table 4: New South Wales' wind and solar generation share increased from just 2% to 6% between 2011-12 and 2016-17.

State	Wind and solar generation as a proportion of total electricity generation 2011-12 (%)	Wind and solar generation as a proportion of total electricity generation 2016-17 (%)	Increase in wind and solar generation
South Australia	26	46	+20
Tasmania	4	12	+8
Victoria	3	9	+6
New South Wales	**2**	**6**	**+4**
Queensland	1	4	+3
Northern Territory	~0	3	+3
Western Australia	5	7	+2

Source: Department of the Environment and Energy (2018b).

Table 5: Eight wind and solar farms in New South Wales began operating in 2018*.

Project	Technology	Capacity (MW)	Month of Accreditation
Silverton wind farm	Wind	199	May 2018
Coleambally solar farm	Solar	189	September 2018
Bodangora wind farm	Wind	113	August 2018
Crookwell 2 wind farm	Wind	96	June 2018
Manildra solar farm	Solar	56	May 2018
Griffith solar farm	Solar	35	January 2018
South Keswick solar farm	Solar	18	May 2018
Narromine solar farm	Solar	11	April 2018

* As at 31st December 2018; table only includes projects with a capacity above 2MW.

Source: Clean Energy Regulator (2018b).

Figure 6: The Silverton wind farm, owned by the Powering Australian Renewables Fund (PARF), is the largest of eight wind and solar farms that began operating in New South Wales in 2018.

Fewer renewable energy projects are being built in New South Wales than other states. In 2018, seventeen wind and solar farms began operating in Queensland and eleven wind and solar farms began operating in Victoria, compared to just eight in New South Wales (excluding projects below 2MW; Clean Energy Regulator 2018b).

New South Wales also has less committed renewable energy capacity than these states (this includes projects that have reached financial close or are under construction) (Clean Energy Regulator 2018b). 2,050MW of renewable energy is committed in Victoria and 1,133MW is committed in Queensland, compared to 983MW in New South Wales (refer to Table 6; Clean Energy Regulator 2018b).

New South Wales could also do more to encourage rooftop solar. 17.8% of New South Wales households have rooftop solar (as of October 2018; refer to Figure 7; APVI 2018). This is higher than Victoria (15.6%) but it is significantly lower than Queensland and South Australia, where over 30% of households have rooftop solar (APVI 2018).

Table 6: Despite having excellent wind and solar resources, New South Wales has less committed new wind and solar capacity than Queensland or Victoria.

State	Capacity of committed wind and solar projects (MW)
Victoria	2,050
Queensland	1,133
New South Wales	**983**

*As at 31st December 2018

Source: Clean Energy Regulator (2018b)

Note: Committed projects are large-scale renewable energy projects that have received all development approvals and reached a final investment decision according to the commercial understanding of the term.

Figure 7: Households and businesses around Australia are installing rooftop solar to reduce their power bills. Bakers Maison has installed a 100kW rooftop solar system on its business in Sydney (pictured).

BOX 3: WHAT EFFECT WILL SNOWY 2.0 HAVE ON GREENHOUSE GAS POLLUTION?

Like all other storage technologies, pumped hydro is a net energy consumer – energy storage technologies consume more electricity from the grid than they give back. To deliver on Australia's Paris Agreement commitments to reduce greenhouse gas pollution in line with keeping global temperatures well below 2°C, it is vital that the electricity that storage technologies use from the grid is not generated from polluting coal or gas power stations.

Most conventional pumped hydro systems have a round-trip efficiency of around 80%. This means they use 20% more electricity than they generate. This is because pumped hydro consumes electricity in order to pump the water uphill again to recharge the system (ESA 2017) and friction and other energy losses occur when the water passes through pipes and pumps at high velocities. However, the Snowy 2.0 project, with a capacity of 2,000MW, has a far lower proposed round-trip efficiency at just 67% at peak power. No adequate explanation for this extremely inefficient design proposal has been provided. This means Snowy 2.0 would use one third more electricity than it would generate (Snowy Hydro 2017). This doesn't include losses from transmission, which would reduce efficiency even further.

With such low efficiency, a significant amount of the electricity supply for Snowy 2.0 needs to come from renewable energy for the project to be less polluting than a peaking gas plant. However, New South Wales (where Snowy 2.0 is proposed to be located) currently has very low levels of renewable energy and electricity supply from renewable energy is highly unlikely to reach 60% by the time Snowy 2.0 opens in 2025. This means Snowy 2.0 could be as polluting – if not more so – than a gas peaking power station (because the electricity to pump the water comes largely from coal at off peak times).

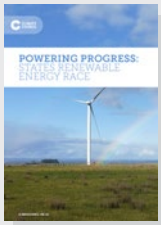
To reduce greenhouse gas pollution from the electricity sector, large-scale pumped hydro should be constructed alongside major investments in new renewable energy. Otherwise, pumped hydro could increase energy demand leading to higher greenhouse gas pollution. For the Snowy 2.0 scheme, this is only assured if New South Wales has a much higher level of renewable energy than it currently does.

BOX 4. THE RENEWABLE ENERGY RACE IN NEW SOUTH WALES

The Climate Council's annual States Renewable Energy Race report compares the states and territories based on their performance across a range of renewable energy metrics. These metrics include each state's percentage of renewable electricity, the proportion of households with solar and policies that support renewable energy.

New South Wales has consistently been at the back of these scorecards. The state finished third last in the renewable energy race in 2018, the same spot as 2017.

For more information on the 2018 scorecard, read the Climate Council's report:



'Powering Progress: States Renewable Energy Race'.

2018 SCORECARD: NEW SOUTH WALES FAST FACTS

Percentage renewable power:

- New South Wales had 12.6% renewable electricity in 2017 consisting mainly of large hydro, decreasing from 17.5% in 2016.

Households:

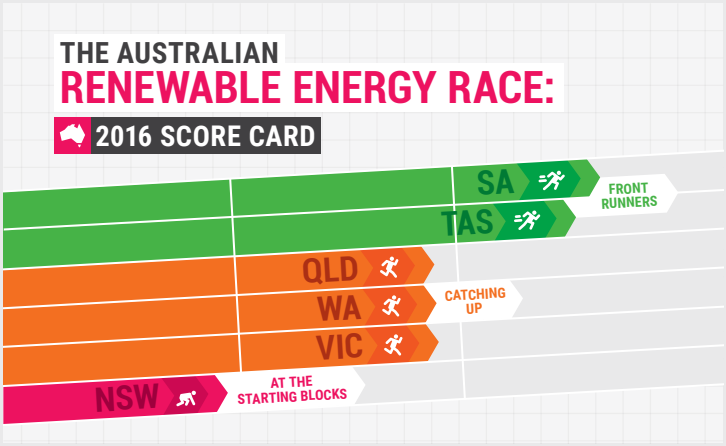
- 17.6% of households in NSW have rooftop solar.

Policy

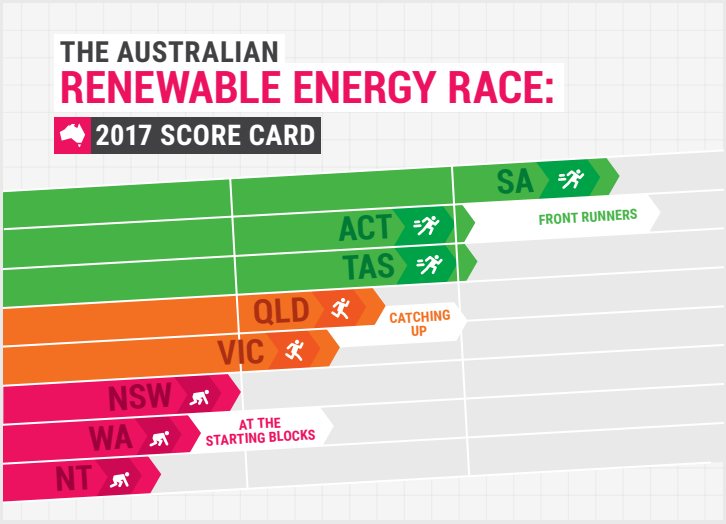
- Net zero emissions target by 2050 (albeit with no clear policy framework).
- Renewable Energy Action Plan in place since 2013. Discontinued in 2018.
- No renewable energy target.

BOX 4. CONTINUED

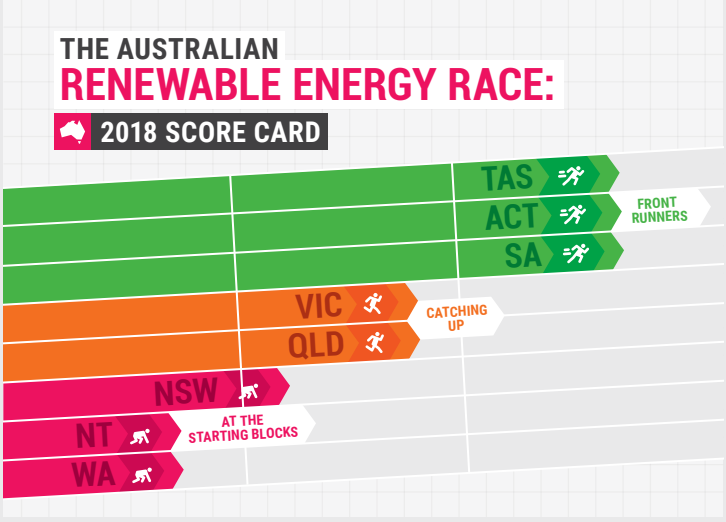
2016 Score Card:



2017 Score Card:



2018 Score Card:



4. Policies to tackle climate change in New South Wales are falling short

New South Wales has few policies in place to encourage investment in renewable energy. The state does not have a renewable energy target or a reverse auction program to support renewable energy (unlike Victoria and Queensland).

However, in the past twelve months, New South Wales has taken some positive steps to encourage renewable energy and storage technologies. While these incremental policies are a step forward, and are being designed in consultation with AEMO to ensure consistency with the National Electricity Market (NEM) overall, they must be backed up with further action (AFR 2018a).

NEW DISPATCHABLE CAPACITY

In October 2018, the New South Wales Government announced that the state government would provide $55 million to support the construction of new large-scale dispatchable electricity capacity. Dispatchable capacity could include renewable energy with energy storage, such as battery storage or pumped hydro, or a new gas power station. Projects can receive grants of up to $10 million and feasibility studies can receive up to $500,000. All projects must have an 'emissions intensity' of below 0.5tCO_2/MWh. This means a project must produce less than 0.5 tonnes of carbon dioxide for every megawatt hour of electricity generation. This rules out any new coal power station from receiving grants but it does not rule out new gas power stations (New South Wales Government 2018b).

The state government supported large-scale solar farms under its now discontinued Renewable Energy Action Plan.

RENEWABLE ENERGY ACTION PLAN

In 2013, the state government launched the New South Wales Renewable Energy Action Plan. This plan included 3 goals and 24 actions with the aim of increasing the amount of renewable energy generation in the state (New South Wales Government 2018c).

Under this plan, the state government provided funding to a number of large scale solar farms in the state and supported a number of community energy projects and businesses to invest in renewable energy.

This plan was discontinued in December 2018 upon completion of the plan's 24 actions (New South Wales Government 2018c). The New South Wales Government has not announced a new plan to replace it.

TRANSMISSION STRATEGY

In October 2018, the New South Wales Government released its Transmission Infrastructure Strategy to guide the development of new transmission projects (New South Wales Government 2018a). Transmission lines transport electricity over long distances from generators to consumers. New transmission is needed to connect new wind and solar farms plus pumped hydro storage to the electricity grid, which in some cases are located long distances from existing transmission built to accommodate coal-fired power generation.

The strategy identified four priority projects, including a new interconnector with South Australia and interconnection expansions with Victoria and Queensland. The strategy also prioritises the development of three renewable energy zones in the New England, Central-West and South-West regions of New South Wales (New South Wales Government 2018a). Once built, these projects should help unlock significant renewable energy investment by increasing the capacity of the electricity network.

FUNDING FOR BATTERY STORAGE AND ROOFTOP SOLAR

New South Wales has announced support for a "virtual power plant" that could include installing rooftop solar and batteries on 40,000 households and businesses. Although these solar and storage systems will be located on different households, the systems will be controlled by the same software. This enables the generation, charge and discharge of energy to be coordinated, so that all the systems effectively operate as one power station – hence the name "virtual power plant".

The $50 million program involves households installing rooftop solar and battery storage to form a 200MW virtual power plant, which could save households up to $1,000 a year (RenewEconomy 2018a).

The state government is also providing $20 million to install 900 battery systems alongside rooftop solar across state schools and hospitals (RenewEconomy 2018b).

In February 2019, the state government announced a ten year program to provide no-interest loans of up to $9,000 for households to install battery storage and up to $14,000 for a solar and battery system. The program could save a household with a quarterly electricity bill of $500 around $285 a year. This could help 300,000 households reduce their electricity bills and add 3,000MWh of battery storage to the energy system (Berejiklian 2019).

New South Wales is creating a virtual power plant across 40,000 households.

Figure 8: The Goonellabah community solar farm was supported by the Lismore City Council as part of its plan to be powered entirely by renewable energy by 2023.

PUMPED HYDRO ROADMAP

The state government has released a pumped hydro roadmap that identifies 7,000MW of potential pumped hydro capacity across 24 WaterNSW sites. Pumped hydro is the world's dominant form of electricity storage. Pumped hydro involves storing electricity by pumping it up to a higher reservoir when there is excess or cheap electricity in the grid (this can come from any source of electricity - wind, solar or coal). The stored water can then quickly generate electricity as needed when the water flows down to a lower reservoir through a turbine. This effectively operates like a battery. In electricity grids with a large amount of wind and solar generation, pumped hydro can help stabilise the grid and reduce reliance on fossil fuel power stations.

The roadmap is intended to guide private sector investment in pumped hydro (New South Wales Government 2018d). The state government is also supportive of the Federal Government's Snowy 2.0 pumped hydro project, which involves the proposed construction of 2,000MW of pumped hydro capacity and associated expansion of grid transmission (refer to Box 3; New South Wales Government 2018e).

NET ZERO EMISSIONS TARGET

Since 2016, New South Wales has had a net zero emissions target by 2050 (New South Wales Government 2016). However, there is currently no plan, policies or interim targets or trajectories on how the state will achieve this target.

New South Wales has a target of net zero emissions by 2050 but no plan to reach this target.

MORE ACTION IS NEEDED TO ENCOURAGE WIND AND SOLAR

New South Wales does not have a comprehensive policy to encourage new renewable energy generation, nor does it have policies in place to enable the state to reach its net zero emissions target in 2050.

New South Wales state government support for new dispatchable capacity, investments in energy storage and a transmission strategy acknowledge that the state will be powered by renewable energy in the future. However, these actions are not a substitute for adopting a policy to encourage renewable energy.

Investment in energy storage like batteries and pumped hydro is important if New South Wales is to transition to very high levels of wind and solar, but currently the state generates just 6% of its electricity from wind and solar (Department of the Environment and Energy 2018b). With such low levels of wind and solar generation, it is possible that large energy storage projects will end up underutilised or instead use coal generation when they are 'charging' (refer to Box 3; Snowy Hydro 2018).

Without a policy to encourage investment in renewable energy once the Federal renewable energy target ends in 2020, it is likely that New South Wales will continue to fall further behind other states like Victoria, Queensland and South Australia.

BOX 5: NEW SOUTH WALES COUNCILS PICKING UP THE SLACK

Local government has been filling the void left by state government inaction, with strong action by metropolitan and regional councils to support renewable energy in New South Wales.

In 2018, the Southern Sydney Regional Organisation of Councils, representing twenty councils in Sydney, announced that it will soon receive 35% of its power needs from renewable energy. These councils have signed a 15-year power purchase agreement with Origin Energy to purchase 14MW of electricity from the 56MW Moree solar farm (AFR 2018b). These councils include Bayside, Campbelltown, Canada Bay, Canterbury-Bankstown, Georges River, Hunters Hill, Inner West, Ku-ring-gai, Lane Cove, Liverpool, Mosman, North Sydney, Parramatta, Randwick, Ryde, Singleton, Sutherland Shire, Waverley, Willoughby and Woollahra.

The Lismore City Council developed an ambitious Renewable Energy Master Plan in 2014 with the aim of generating all its electricity from renewable energy by 2023. This includes the construction of two 100kW solar farms: a rooftop solar farm at the Goonellabah Sports and Aquatic Centre (refer to Figure 8) and a floating solar farm at the east Lismore Sewage Treatment plant (refer to Figure 1; Lismore City Council 2018). The Goonellabah solar plant provides 15% of the aquatic centre's power needs, while the floating solar farm provides 12% of the treatment plant's energy requirements (Lismore City Council 2018).

Muswellbrook Shire Council is supporting a new pumped hydro project in the Hunter Valley by signing a deed with AGL. The pumped hydro facility is estimated to cost $300 million and have 250MW of capacity. It will be able to power every house in the Hunter region for up to 8 hours (The Newcastle Herald 2019).

The City of Newcastle is collaborating with the Clean Energy Finance Corporation to build a 5MW solar farm in the region (refer to Figure 9). The council hopes the Summerhill solar farm will significantly reduce the council's annual $4 million electricity bill, after it doubled over the past two years. It is estimated that the solar farm will save $9 million over 30 years (Newcastle Herald 2018).

Local government action will continue to be critical to Australia's transition to renewable energy into the future.

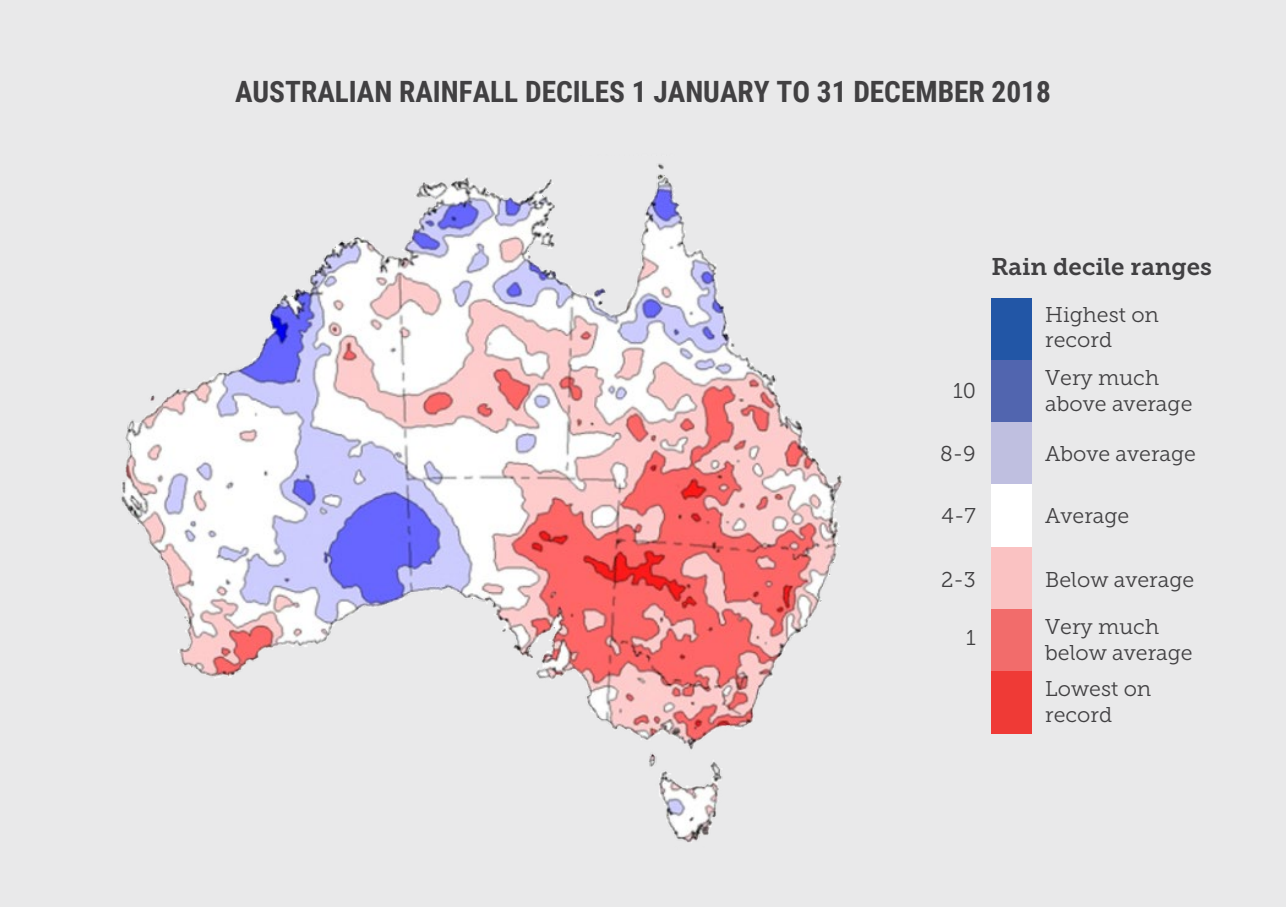
Figure 9: Construction on the Summerhill Waste Management Centre's solar farm began in November 2018 (pictured), supported by the City of Newcastle.

5. Climate impacts in New South Wales

New South Wales is highly exposed to the impacts of climate change. Greenhouse gas pollution must be reduced to keep global temperatures under 2°C to prevent dangerous climate change and worsening extreme weather events in New South Wales.

The state is already experiencing the impacts of climate change. In 2018, New South Wales saw its hottest year on record for mean temperature - 1.68°C above the 1961-1990 average. Mean maximum temperatures were also the hottest on record for New South Wales – 2.13°C above the 1961-1990 average (BoM 2019). New South Wales also suffered from rainfall that was significantly below average during 2018 (refer to Figure 10). Annual rainfall for the year over the state was the sixth lowest on record (since 1900). The dry conditions during 2018 over eastern Australia were driven by a combination of climate change and natural variability (BoM 2019).

Figure 10: Rainfall in New South Wales was significantly below average in 2018. This is part of a long term trend, with rainfall declining by 11% in southeast Australia since the 1990s.



Source: Bureau of Meteorology (2019).

The unusually warm and dry conditions led to debilitating drought and high fire danger throughout 2018. Bushfires burned in New South Wales in all but two months of the year. In March, a bushfire on the south coast of New South Wales at Tathra destroyed more than 70 homes and damaged a further 39 homes (BoM 2019). Many local government areas in New South Wales were declared in the bushfire danger period in late winter – the earliest on record. Between 80 and 100 active bushfires burned across New South Wales in August alone. Another fire – the Bega Valley fire at Bemboka – burned from August 15 until near the end of September, destroying two homes and 19,000 hectares of bushland (BoM 2019).

These events are part of a long-term trend. There has been an increase in the frequency, intensity and duration of heatwaves in New South Wales since 1911. Increases in heatwave intensity (the maximum temperatures reached in a heatwave) have been strongest along the Great Dividing Range and the far west of the state. The far west and the eastern seaboard have experienced increases in the frequency

Climate change, driven by the burning of fossil fuels, is already affecting New South Wales.

of heatwaves, and the far west and southern coastal areas have experienced increases in the duration of heatwaves. For example, there are 18 more heatwave days per year in the south-east of New South Wales now than in the beginning of the 20th Century (OEH 2015). Extreme heatwaves have already led to a 10% increase in both deaths and ambulance callouts in New South Wales between 2005 and 2015 (Jegasothy et al. 2017).

There has also been a decline in April-October rainfall since the 1990s, with rainfall in southeast Australia declining by 11% over this period (BoM 2019). More hot days and heatwaves and reduced cool season rainfall have contributed to an increase in extreme fire weather days over most of New South Wales, and a lengthening of the bushfire season (Climate Council 2017; CSIRO and BoM 2018).

The impact of climate change will become more intense in the coming decades if greenhouse gas pollution is not reduced. By 2030, New South Wales will experience on average an additional one to two heatwaves each year. The longest heatwave is projected to last an average 1.5 to 3.5 more days in most regions of New South Wales by 2030 (NSW Chief Scientist & Engineer 2017).

By 2030, maximum temperatures are expected to rise by 0.7°C in New South Wales and continue to rise by 2.1°C by 2070 (compared to the baseline modelled climate between 1990 and 2009). The greatest increases are projected in north-western New South Wales (NARCliM 2019)[1].

By 2030, the number of hot days (with a maximum temperature above 35°C) is projected to increase by an average of nine across the state (compared to the baseline modelled climate between 1990 and 2009) (NARCliM 2019). North-western New South Wales will experience the greatest increase, with an additional 10-20 hot days by 2030 and over 40 additional hot days by 2070. This region currently experiences 50-80 hot days, meaning that some parts of north-western New South Wales (e.g. the region around Bourke) will experience temperatures above 35°C for about one third of the year by 2070. New South Wales is also expected to experience an increase in average fire weather, and days rated as severe or above (as measured using the McArthur Forest Fire Danger Index or FFDI)[2]. Fire danger is expected to increase most in spring and summer in the coming decades, with the western half of the state most heavily affected.

---

[1] Based on modelled temperatures. Maximum temperatures are rising faster than expected and in many cases, temperatures are already reaching what was projected for 2030.

[2] Forest Fire Danger Index (FFDI) values below 12 indicate low to moderate fire weather, 12-25 high, 25-49 very high, 50-74 severe, 75-99 extreme and above 100 catastrophic. The Bureau of Meteorology issues Fire Weather Warnings when the FFDI is forecast to be over 50.

North-western New South Wales will experience an extra 40 days above 35 degrees by 2070 if greenhouse gas pollution is not reduced.

This will have numerous impacts, including on human health, ecosystems, infrastructure and the economy. Climate change is projected to increase deaths and illnesses related to heat stress, and potentially increase food and water borne illnesses (OEH 2016). Climate change is also emerging as a serious threat to ecosystems, posing challenges to conservation (OEH 2016). The costs associated with damages from extreme weather events is also likely to rise as their severity and/or frequency increases, with disasters already costing New South Wales $3.6 billion per year (Deloitte Access Economics 2017).

Extreme weather events will also affect the electricity system, especially heatwaves and flooding. Electricity demand increases during heatwaves and large coal and gas power stations are less reliable in extreme hot weather (NSW Chief Scientist & Engineer 2017). Extreme storms can cause damage to power lines and substations, leading to power outages. Flooding can also affect rail transport of coal to power stations in the state and may cause landslides in coal mines (NSW Chief Scientist & Engineer 2017).

For more information on the effects of climate change in New South Wales, read the following Climate Council reports:

'2017: Another record-breaking year for heat and extreme weather'.

'Earlier, more frequent, more dangerous: Bushfires in New South Wales'.

Climate change is driving more frequent heatwaves, making coal power stations less reliable.

Figure 11: The Bayswater coal power station. As heatwaves become more intense as a result of climate change, ageing coal power stations will become increasingly unreliable.

6. Conclusion: New South Wales has some catching up to do

After almost a decade of policy stagnation, New South Wales can show leadership on climate change once again by adopting ambitious renewable energy policies. By reconfiguring the transmission network and embracing both rooftop solar and storage as well as large scale renewable energy and storage, New South Wales can sustainably reduce greenhouse gas pollution and electricity prices while ensuring the state continues to have a secure and reliable supply of electricity.

There is massive potential for new jobs and investment in New South Wales in a renewable energy future. The Climate Council's Renewable Energy Jobs report (2016b) found that New South Wales would experience the highest jobs growth of any state with a 50% renewable energy target, with the creation of 11,000 jobs. 20,000MW of renewable energy capacity has received or is awaiting planning approval – twice the capacity of the state's entire fleet of coal power stations. But without clear policies, many of these projects will never be built.

In 2003 New South Wales led the world in climate policy. Today New South Wales is supporting investment in new dispatchable technologies, energy storage and new transmission. However, with a heavily polluting electricity grid dominated by an ageing fleet of coal power stations, this is not enough.

Embracing renewable energy would create jobs and drive investment in New South Wales.

References

ABC (Australian Broadcasting Corporation) (2010) Questions over NSW's commitment to reducing emissions. The World Today. 26 March 2010. Accessed at: https://www.abc.net.au/radio/programs/worldtoday/questions-over-nsw-governments-commitment-to/382698

ABC (2017) Whyalla steelworks owner Sanjeev Gupta buys majority stake in renewable firm Zen Energy. 20 September 2017. Accessed at: http://www.abc.net.au/news/2017-09-20/sanjeev-gupta-buys-controlling-stake-in-renewablesfirm/8964448

ACT Government (2016) Wind farms final piece in 100% by 2020 plan. 23 August 2016. Accessed at: https://www.cmtedd.act.gov.au/open_government/inform/act_government_media_releases/corbell/2016/wind-farms-final-piece-in-100-by-2020-plan

AEMO (Australian Energy Market Operator) (2017a) 2017 Electricity Statement of Opportunities. Accessed at: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/NEM-Electricity-Statement-of-Opportunities/2017-NEM-ESOO

AEMO (2017b) System Event Report New South Wales, 10 February 2017. 22 February 2017. Accessed at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Market_Notices_and_Events/Power_System_Incident_Reports/2017/Incident-report-NSW-10-February-2017.pdf

AEMO (2018a) Generation Information Page. 2 November 2018. Accessed at: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information

AEMO (2018b) Integrated System Plan. Accessed at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2018/Integrated-System-Plan-2018_final.pdf

AFR (Australian Financial Review) (2018a) NSW turbocharges grid to tap wind and solar power surge. 12 November 2018. Accessed at: https://www.afr.com/news/nsw-turbocharges-grid-to-tap-wind-and-solar-power-surge-20181108-h17oaf

AFR (2018b) Sydney councils go solar in Origin deal as Visy signs $30m for waste recycling. 2 October 2018. Accessed at: https://www.afr.com/news/sydney-councils-go-solar-in-deal-with-origin-as-visy-wins-30m-for-waste-recycling-20181002-h164q3

APH (Parliament of Australia) (2017) Electricity markets and the role of coal fired power stations. Accessed at: https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Coal_fired_power_stations/~/media/Committees/ec_ctte/Coal_fired_power_stations/Final%20Report/c02.pdf

APVI (Australian Photovoltaic Institute) (2018) Mapping Australian Photovoltaic installations. 25 October 2018. Accessed at: http://pv-map.apvi.org.au/historical#4/-26.67/134.12

Berejiklian G (2019) Extra bill relief with solar energy & battery roll out. 10 February 2019. Accessed at: https://nsw.liberal.org.au/candidates/gladys-berejiklian/news/articles/EXTRA-BILL-RELIEF-WITH-SOLAR-ENERGY?_ga=2.26187578.647025708.1549932823-1742903155.1539047526

BNEF (Bloomberg New Energy Finance) (2018) Levelised Cost of Energy Analysis.

BoM (Bureau of Meteorology) (2019) Annual Climate Statement - Temperature. Accessed at: http://www.bom.gov.au/climate/current/annual/aus/#tabs=Overview

City of Newcastle (2018) Summerhill solar farm to be built with CEFC finance. 7 March 2018. Accessed at: http://newcastle.nsw.gov.au/Council/News/Latest-News/CEFC-finance-to-build-Newcastle-s-solar-farm

Clean Energy Regulator (2016) History of the scheme. 30 November 2016. Accessed at: http://www.cleanenergyregulator.gov.au/RET/About-the-Renewable-Energy-Target/History-of-the-scheme

Clean Energy Regulator (2018a) Electricity sector emissions and generation data 2016-17. 24 September 2018. Accessed at: http://www.cleanenergyregulator.gov.au/NGER/National%20greenhouse%20and%20energy%20reporting%20data/electricity-sector-emissions-and-generation-data/electricity-sector-emissions-and-generation-data-2016-17?Paged=TRUE&p_Title=Broome%20LNG%20Power%20Station&p_ID=575&View=%7b14EFC728-3B4A-49C8-BFA7-BACFD39B7323%7d&PageFirstRow=51

Clean Energy Regulator (2018b) Large-scale Renewable Energy Target supply data. 17 January 2019. Accessed at: http://www.cleanenergyregulator.gov.au/RET/About-the-Renewable-Energy-Target/Large-scale-Renewable-Energy-Target-market-data/large-scale-renewable-energy-target-supply-data#Power-stations-and-projects-by-status

Climate Council (2014) The Australian Renewable Energy Race: Which States are Winning or Losing? Accessed at: http://www.climatecouncil.org.au/uploads/ee2523dc632c9b01df11ecc6e3dd2184.pdf

Climate Council (2016a) Game On: The Australian Renewable Energy Race. Accessed at: http://www.climatecouncil.org.au/uploads/2acac0b824742ec83f99676255ae5a81.pdf

Climate Council (2016b) Renewable Energy Jobs: Future Growth in Australia. Accessed at: https://www.climatecouncil.org.au/uploads/7b40d7bbefbdd94979ce4de2fad52414.pdf

Climate Council (2017a) Renewables Ready: States Leading the Charge. Accessed at: http://www.climatecouncil.org.au/uploads/9a3734e82574546679510bdc99d57847.pdf

Climate Council (2017b) Earlier, More Frequent, More Dangerous: Bushfires in New South Wales. Accessed at: https://www.climatecouncil.org.au/uploads/02401b8a369a37c7763b3c2b4171a517.pdf

Climate Council (2018a) Powering Progress: States Renewable Energy Race. Accessed at: https://www.climatecouncil.org.au/wp-content/uploads/2018/10/States-renewable-energy-report-1.pdf

Climate Council (2018b) 2017: Another record-breaking year for heat and extreme weather. Accessed at: https://www.climatecouncil.org.au/uploads/8e9c2b91ce3c3ebb7d97e403a6fdf38e.pdf

CSIRO and BoM (Commonwealth Scientific and Industrial Research Organisation and the Bureau of Meteorology) (2018) State of the Climate 2018. Accessed at: http://www.bom.gov.au/state-of-the-climate/State-of-the-Climate-2018.pdf

Deloitte Access Economics (2017) Building Resilience to Natural Disasters in our States and Territories. Australian Business Roundtable for Disaster Resilience and Safer Communities. Accessed at: http://australianbusinessroundtable.com.au/assets/documents/ABR_building-resilience-in-our-states-and-territories.pdf

Department of the Environment and Energy (2018a) State and Territory Greenhouse Gas Inventories 2016. Accessed at: http://www.environment.gov.au/system/files/resources/a97b89a6-d103-4355-8044-3b1123e8bab6/files/state-territory-inventories-2016.pdf

Department of the Environment and Energy (2018b) Australian Energy Update 2018. Accessed at: https://www.energy.gov.au/publications/australian-energy-update-2018

Department of Planning and Environment (2018) NSW renewable energy resources map. Accessed at: https://www.resourcesandgeoscience.nsw.gov.au/investors/renewable-energy/renewable-resources-map

Energy Storage Association (2017) Pumped Hydroelectric Storage. Accessed at: http://energystorage.org/energy-storage/technologies/pumped-hydroelectric-storage

IPART (Independent Pricing and Regulatory Tribunal New South Wales) (2013) Greenhouse Gas Reduction Scheme. Accessed at: https://www.ipart.nsw.gov.au/Home/Industries/Energy/Energy-Savings-Scheme/Greenhouse-Gas-Reduction-Scheme

Jegasothy E, McGuire R, Nairn J, Fawcett R and Scalley B (2017) Extreme climatic conditions and health service utilisation across rural and metropolitan New South Wales. International Journal of Biometeorology (2017) 61:1359. Accessed at: https://doi.org/10.1007/s00484-017-1313-5

Lismore City Council (2018) Solar launch shines light on renewable energy partnerships. 30 January 2018. Accessed at: https://www.lismore.nsw.gov.au/cp_themes/news/page.asp?p=DOC-OFP-14-07-70

McConnell D (2018) Coal capacity factors in the NEM, 2017-18. 12th July 2018. Accessed at: https://figshare.com/articles/Coal_capacity_factors_in_the_NEM_2017-18/6809294

NARCliM (2019) NSW Climate projections map for 2060-2079. Viewed on 9 January 2019. Accessed at: https://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Interactive-map

Newcastle Herald (2018) Solar farm construction begins at Summerhill Waste Management Centre. 13 November 2018. Accessed at: https://www.theherald.com.au/story/5755698/work-starts-on-city-solar-farm-transforming-old-landfill-site/

New South Wales Government (2006) NSW Renewable Energy Target: Explanatory Paper. November 2006. Accessed at: https://www.environment.nsw.gov.au/resources/climatechange/NRETPaperFINAL.pdf

New South Wales Government (2011) NSW 2021: A plan to make NSW number one. Accessed at: https://www.ipc.nsw.gov.au/sites/default/files/file_manager/NSW2021_WEBVERSION.pdf

New South Wales Government (2015) Community Attitudes to Renewable Energy in NSW. Accessed at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Energy-savings-and-resource-efficiency/community-attitudes-to-renewable-energy-nsw-150419.pdf

New South Wales Government (2016) Factsheet: achieving net-zero emissions by 2050. Accessed at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Climate-change/achieving-net-zero-emissions-by-2050-fact-sheet-160604.pdf

New South Wales Government (2018a) NSW Transmission Infrastructure Strategy. Accessed at: https://energy.nsw.gov.au/renewables/clean-energy-initiatives/transmission-infrastructure-strategy#-nsw-transmission-infrastructure-strategy-

New South Wales Government (2018b) NSW Emerging Energy Program Overview. Accessed at: https://energy.nsw.gov.au/sites/default/files/2018-10/DPE8811%20EmergingEnergy-WEB.pdf

New South Wales Government (2018c) Renewable Energy Action Plan. Accessed at: https://energy.nsw.gov.au/renewables/renewable-energyoffers/renewable-energy-action-plan

New South Wales Government (2018d) Pumped Hydro Roadmap. Accessed at: https://energy.nsw.gov.au/renewables/clean-energy-initiatives/hydro-energy-and-storage

New South Wales Government (2018e) Snowy Hydro transfer creates investment bonanza in regional NSW. 2 March 2018. Accessed at: https://www.nsw.gov.au/news-and-events/news/snowy-hydro-transfer-creates-investment-bonanza-in-regional-nsw/

NSW Chief Scientist & Engineer (2017) Final report from the Energy Security Taskforce. 19 December 2017. Accessed at: http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0019/136711/171219-MASTER-NSW-Energy-Security-Taskforce-report-FINAL-SIGNED.pdf

OEH (Office of Environment and Heritage) (2015) Heatwaves: Climate Change Snapshot. NSW Government. Accessed at: https://climatechange.environment.nsw.gov.au/-/media/NARCLim/Files/Climate-Change-Impact-Reports/Heatwaves-Climate-Change-Impact-Snapshot.pdf

OEH (2016) Fact sheet: Climate change in NSW. NSW Government. Accessed at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Climate-change/climate-change-fact-sheet-160595.pdf

RenewEconomy (2018a) NSW proposes 200MW virtual power plant, in bid to bolster grid. 14 November 2018. Accessed at: https://reneweconomy.com.au/nsw-proposes-200mw-virtual-power-plant-in-bid-to-bolster-grid-56564/

RenewEconomy (2018b) NSW launches $20m battery round, to shift hospitals and schools to solar and storage. 2 November 2018. Accessed at: https://reneweconomy.com.au/nsw-launches-20m-battery-round-to-shift-hospitals-and-schools-to-solar-and-storage-51952/

RenewEconomy (2018c) Gupta doubles down on green industrial plans for Whyalla, powered by cheap renewables. 10 December 2018. Accessed at: https://reneweconomy.com.au/gupta-doubles-down-on-green-industrial-plans-for-whyalla-powered-by-cheap-renewables-24759/

RenewEconomy (2018d) "No need for new coal:" Sun Metals formally opens solar farm in "George" town. 17 August 2018. Accessed at: https://reneweconomy.com.au/no-need-for-new-coal-sun-metals-formally-opens-solar-farm-in-george-town-26798/

Snowy Hydro (2017) Snowy 2.0 Feasibility Study. Accessed at: https://www.snowyhydro.com.au/our-scheme/snowy20/snowy-2-0-feasibility-study/

Snowy Hydro (2018) NEM outlook and Snowy 2.0. Report prepared for Snowy Hydro Limited by Marsden Jacob. Accessed at: https://www.snowyhydro.com.au/wp-content/uploads/2018/01/MJA_ReportFinal_Jan2018.pdf

The Australia Institute (2019) Gas and Coal Watch. Accessed at: http://www.tai.org.au/gas-coal-watch

The Newcastle Herald (2018) Tomago Aluminium says NSW power grid in crisis. 9 June 2018. Accessed at: https://www.theherald.com.au/story/5456848/tomago-aluminium-hits-out-at-power-shortage/

The Newcastle Herald (2019) The Upper Hunter town synonymous with coal has partnered with AGL for a major dispatchable energy project. 6 January 2019. Accessed at: https://www.theherald.com.au/story/5829317/powering-on-agl-and-muswellbrook-council-sign-pumped-hydro-agreement/

Tomago Aluminium (2018) Tomago Aluminium. Accessed at: http://www.tomago.com.au/

Image Credits

Cover photo: 'Bayswater power station vertical' by Jeremy Buckingham licensed under CC BY 2.0.

Page 2: Figure 1 "IMG_1362". Image courtesy of Starfish Initiatives.

Page 8: Figure 3 'Inside the Liddell power station'. Image courtesy of AGL Energy.

Page 11: Figure 5 'Vales Point power station'. Image courtesy of Delta Electricity.

Page 14: Figure 6 'Silverton Wind Farm'. The Silverton Wind Farm is owned by the Powering Australian Renewables Fund (PARF). Image courtesy of PARF.

Page 15: Figure 7 'Bakers Maison rooftop solar'. Image courtesy of Smart Commercial Solar.

Page21: Figure 8 "DJI_0003-5 – Copy". Image courtesy of Starfish Initiatives.

Page 25: Figure 10 Bureau of Meteorology (2019) Annual climate statement 2018. Accessed at: http://www.bom.gov.au/climate/current/annual/aus/#tabs=Maps

Page 28: Figure 11 'Bayswater power station vertical' by Jeremy Buckingham licensed under CC BY 2.0.

Thank you for supporting the Climate Council.

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

CLIMATE COUNCIL

facebook.com/climatecouncil

twitter.com/climatecouncil

info@climatecouncil.org.au

climatecouncil.org.au

The Climate Council is a not-for-profit organisation and does not receive any money from the Federal Government. We rely upon donations from the public. We really appreciate your contributions.

DONATE climatecouncil.org.au/donate