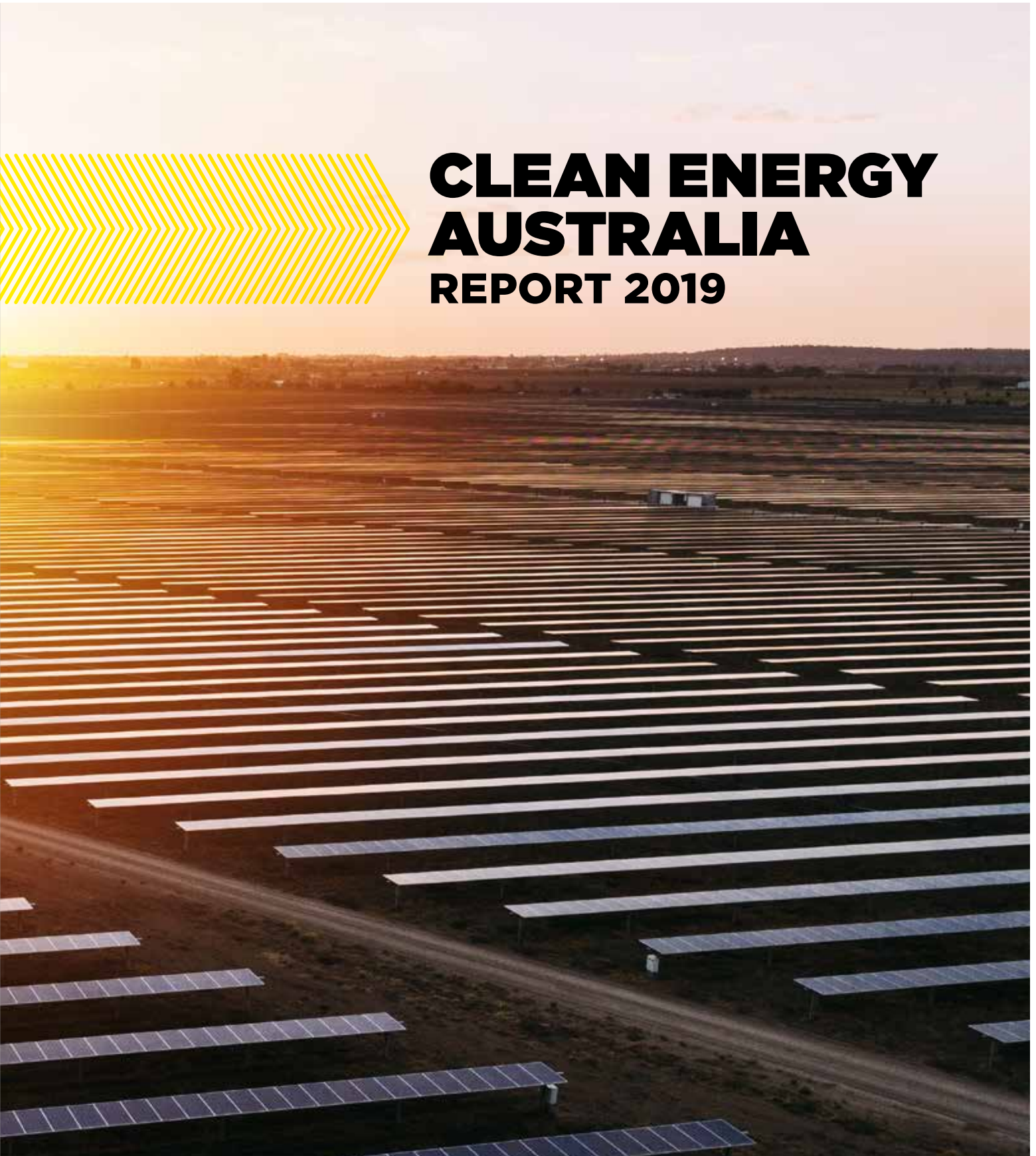




CLEAN ENERGY AUSTRALIA REPORT 2019





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INTRODUCTION



Kane Thornton
Chief Executive,
Clean Energy Council

The vision of an Australia powered by clean energy is now well and truly in sight.

Forget the original Snowy Hydro project or the 2012 rooftop solar boom – nothing comes close to the year that our industry had in 2018. And the good news is that there is much more to come if we can just keep the momentum going.

Many of the records set by the industry in 2017 were smashed in 2018. Investment in large-scale clean energy projects doubled to more than \$20 billion in 2018 as 38 projects were completed throughout the year. And with 87 large-scale renewable energy projects under construction or financially committed at the beginning of 2019, the outlook for large-scale renewables has never been brighter.

Not to be outdone, rooftop solar also surpassed the record that it set in 2017, with 1.55 GW of solar installed on Australian households and businesses in 2018. The number of Australian households with rooftop solar passed 2 million in 2018, meaning that one in five Australian households have now turned to solar to reduce their electricity bills.

Energy storage also made significant gains in 2018, with several new utility-scale batteries installed across the country. The grid support services provided by these batteries were demonstrated by the performance of the Hornsdale Power Reserve, which saved consumers up to \$50 million in costs associated with keeping the power system stable.

Unfortunately, the politics around energy reached another new low in 2018, with the Federal Government opting to tear itself apart rather than implement its own National Energy Guarantee. While the 2019 Federal Election will create another pivotal year for clean energy in Australia, we have thankfully reached a point where politics isn't as existential to the industry as it once was.

The Federal Government did take some steps in the right direction at the beginning of 2019 though, approving Snowy 2.0 and backing Tasmania's Battery of the Nation project. The construction of these significant projects could complement our rapidly-

ABOUT US

growing wind and solar plants, further accelerating the transition to a clean energy future.

Electricity prices remained stubbornly high in 2018, but thankfully relief is in sight. The considerable amount of new wind and solar capacity that has entered the market in recent years has already begun to reduce wholesale prices. The cost of new wind and solar – even when backed by storage – is now lower than the cost of new coal generation, meaning that wholesale prices should continue to fall as more clean energy comes online.

While there is still much to be done, particularly in relation to improving the grid and energy market and how it integrates renewable energy and energy storage, 2018 was a phenomenal year. The vision of an Australia powered by clean energy is now well and truly in sight, and it is with great optimism that I look forward to another ground-breaking year for the Australian clean energy industry.

The Clean Energy Council is the peak body for the renewable energy and energy storage industry in Australia. We represent and work with hundreds of leading businesses operating in solar, wind, hydro, bioenergy, energy storage, geothermal and marine along with more than 6000 solar and battery storage installers.

We are committed to accelerating the transformation of Australia's energy system to one that is smarter and cleaner.

The Clean Energy Council leads and supports the growth of the clean energy industry in Australia by:

- shaping policy
- developing standards and regulations and ensuring the integrity of the industry
- promoting the industry
- providing a range of valuable services to our members, customers and partners.

2018 SNAPSHOT



100%

increase in investment
in large-scale energy
projects in 2018

14.5 GW

of new energy generation
under construction or
financially committed
at the end of 2018

21%

of total electricity generation
from renewable sources – its
highest ever level



In 2017 records were broken. In 2018 they were smashed.

By any measure, 2018 was a remarkable year for the Australian clean energy industry.

Investment in large-scale renewable energy projects was double that of the record-breaking 2017, increasing from \$10 billion in 2017 to \$20 billion in 2018. By year's end, 14.5 gigawatts (GW) of new generation was under construction or financially committed – equivalent to more than four times the energy output of the Liddell Power Station.

New large-scale wind and solar projects are being built more efficiently than ever before, and renewable energy continues to be the lowest-cost type of new energy generation that can be built, attracting local and international capital. Incentives provided by the federal Renewable Energy Target (RET) and other state policies propelled investment in 2018.

In January, the Clean Energy Regulator (CER) confirmed that the large-scale Renewable Energy Target of 33,000 gigawatt hours (GWh) by 2020 would be met¹ – a significant milestone for the industry. With 87 large-scale renewable

energy projects under construction or financially committed at the end of 2018, it is clear the sector will meet the RET well ahead of schedule.

Electricity generated by renewables increased to 21 per cent of total power generation in 2018 to reach its highest ever level. Clean energy now powers the equivalent of more than 10 million Australian homes, which is more than all the households currently in Australia.

With high electricity prices never far from the headlines, Australian households and businesses continued to embrace rooftop solar in record numbers to help manage costs in 2018. By December, the CER confirmed that a whopping 2 million households – one in five – now host rooftop solar. On average, six solar panels were being installed per minute in Australia in 2018, with the commercial sector growing by 45 per cent and the residential sector just a whisker behind, with a 43 per cent rise.

Despite falling project costs and the achievement of record-breaking milestones, the year brought with it some frustration and disappointment

¹ Clean Energy Regulator, media release, *Record year of investment means Australia's 2020 Renewable Energy Target will be met*, 23 January 2018, <http://www.cleanenergyregulator.gov.au/RET/Pages/News%20and%20updates/NewsItem.aspx?ListId=19b4efbb-6f5d-4637-94c4-121cf96f96f9&ItemId=468>

2018 SNAPSHOT CONTINUED

45%

growth in commercial solar installations throughout 2018

1 in 5

Australian households now have rooftop solar

6

solar panels installed every minute in 2018

Image: Griffith Solar Farm, New South Wales

for industry. Towards the end of 2017, there was cautious optimism across the sector that, despite its shortcomings, the National Energy Guarantee (NEG) had attracted broad enough support to deliver the energy policy certainty many had long called for.

But by August 2018, as yet another prime minister fell victim to the decade-long Energy Wars, hope of a breakthrough had disappeared. The new Morrison-led Coalition declared the NEG dead, abandoning any notion of emissions reduction and instead favouring a 'big stick' attack directed at

retailers and a rushed plan to underwrite new investment in 'firmed generation' – what Prime Minister Scott Morrison referred to on radio as "fair dinkum power". Meanwhile, Federal Labor said it would revive the NEG should it win the 2019 Federal Election, as well as support a 50 per cent renewable energy target by 2030.

In December, a benchmark study from the CSIRO and Australian Energy Market Operator confirmed that the cost of new wind and solar – even with six hours of storage included – is lower than the cost of new coal generation.²

Despite falling costs and record-breaking investment, fears remain that the billion-dollar economic boom from renewable energy, particularly in regional Australia, could come to an end if the energy policy debate is left to languish unresolved. At the close of 2018, a bipartisan solution on energy policy remained elusive.

² CSIRO, media release, *Annual update finds renewables are cheapest new build power*, 21 December 2018, <https://www.csiro.au/en/News/News-releases/2018/Annual-update-finds-renewables-are-cheapest-new-build-power>

ANNUAL ELECTRICITY GENERATION IN 2018



● Renewables 21%
● Fossil fuels 79%

RENEWABLE GENERATION BY TECHNOLOGY TYPE



● Hydro 35.2%
● Wind 33.5%
● Small-scale solar PV 19.6%
● Bioenergy 7.1%
● Large-scale solar PV 3.9%
● Medium-scale solar PV 0.8%

RENEWABLE ENERGY GENERATION³

TECHNOLOGY	GENERATION (GWh)	PERCENTAGE OF RENEWABLE GENERATION	PERCENTAGE OF TOTAL GENERATION	EQUIVALENT NUMBER OF HOUSEHOLDS POWERED OVER COURSE OF THE YEAR
Hydro	17,002	35.2%	7.5%	3,699,211
Wind	16,171	33.5%	7.1%	3,518,452
Small-scale solar PV	9,452	19.6%	4.2%	2,056,656
Bioenergy	3,412	7.1%	1.5%	742,418
Large-scale solar PV	1,875	3.9%	0.8%	407,940
Medium-scale solar PV	367	0.8%	0.2%	79,898
TOTAL	48,279	100%	21.3%	10,504,576

³ Green Energy Markets. Electricity generation equivalent in households is calculated using a weighted national average consumption level of 4.596 MWh (from Australian Energy Market Commission, *Residential electricity price trends 2018*, 21 December 2018, <https://www.aemc.gov.au/sites/default/files/2018-12/2018%20Price%20Trends%20-%20Final%20Report%20-%20CLEAN.PDF>)

RENEWABLE ENERGY PENETRATION BY STATE⁴



RENEWABLE ENERGY PENETRATION BY STATE⁴

STATE	TOTAL GENERATION (GWh)	FOSSIL FUEL GENERATION (GWh)	TOTAL RENEWABLE GENERATION (GWh)	PENETRATION OF RENEWABLES
TAS	12,083	499	11,584	95.9%
SA	13,506	6354	7152	53.0%
VIC	48,014	38,106	9908	20.6%
WA	18,950	15,876	3073	16.2%
NSW	69,085	58,730	10,355	15.0%
QLD	65,066	58,860	6206	9.5%
NATIONAL	226,703	178,424	48,279	21.3%

⁴ Green Energy Markets. Total generation includes NEM and WEM data and small-scale solar PV. The ACT is part of the NSW region and there is no data available for the small NT grid.

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CASE STUDY

NEG JOINS CARBON PRICE ON THE CLIMATE SCRAPHEAP

The start of 2018 held some promise that the Turnbull Government's National Energy Guarantee (NEG) might deliver the coherent policy solution that the industry had been calling for.

Then-Energy Minister, Josh Frydenberg, secured broad support for the NEG from business groups, the energy industry and consumers, while negotiations continued with the states and territories.

However, just when the finish line was in sight, Prime Minister Turnbull was forced to abandon the emissions component of the NEG in an attempt to quell a revolt within his own party and save

his leadership. It didn't work, and Scott Morrison was subsequently elected Prime Minister by the Liberal Party.

In September, Prime Minister Morrison confirmed that the NEG was dead. While organisations across the business, energy and community sectors grieved, new Energy Minister, Angus Taylor, announced new measures to try to reign in retail prices, plus a plan to underwrite new investment in firmed generation capacity – including coal.

Recognising the broadly-held support for the NEG, Labor adopted the policy and will take it to the 2019 Federal

Election, but with a higher emissions reduction target for electricity of 45 per cent by 2030. It also left the door open to pursue direct clean energy investment options if the trend towards partisanship continued.

With energy shaping up to be a key battleground in the 2019 Federal Election, the decade-long wait for a long-term national energy policy may finally be decided – for better or for worse.

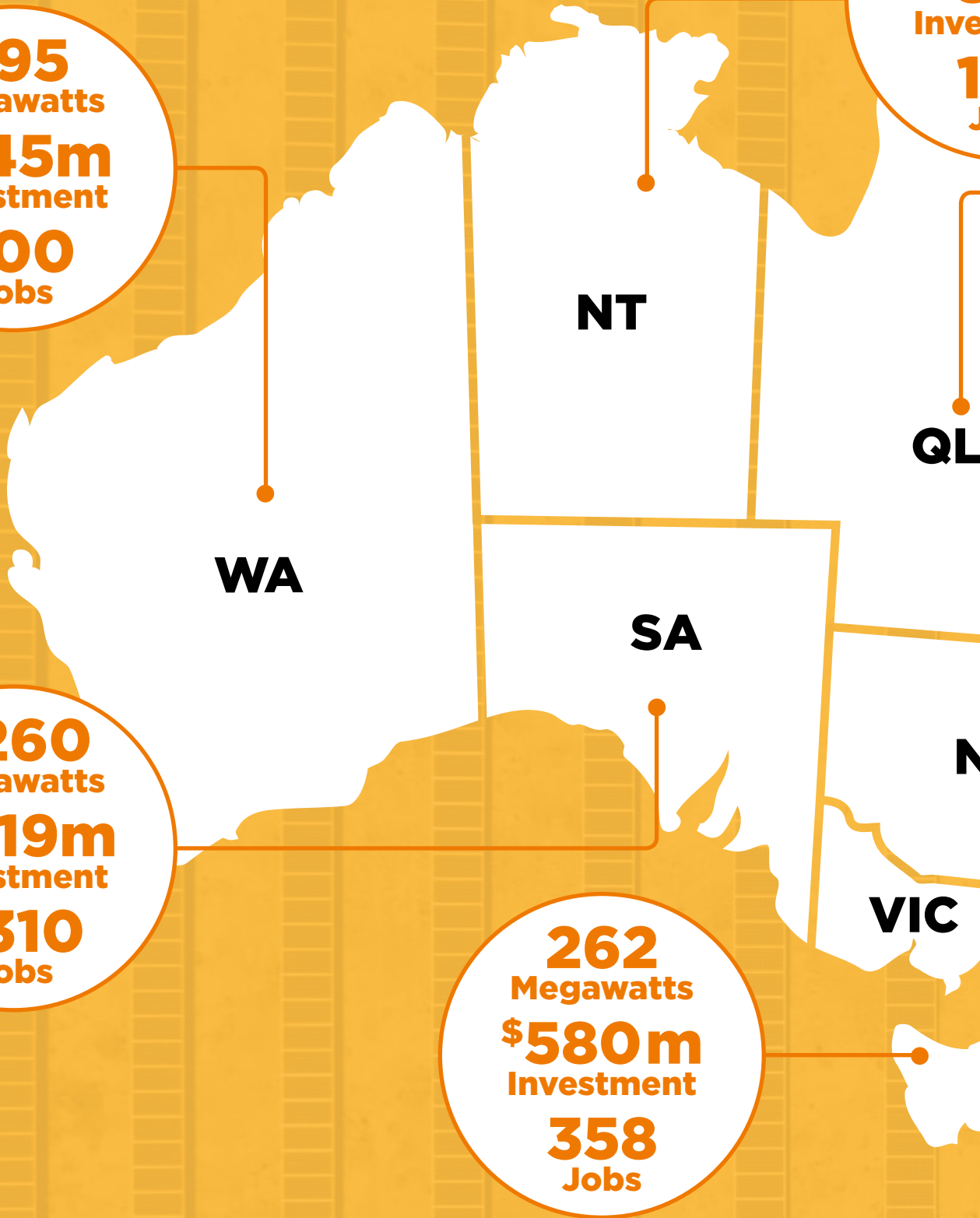
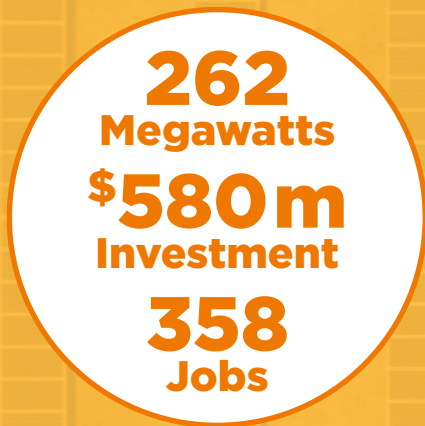
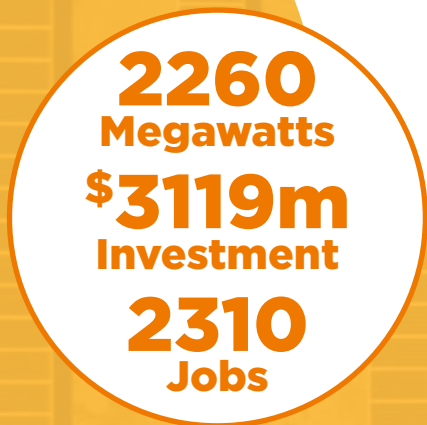
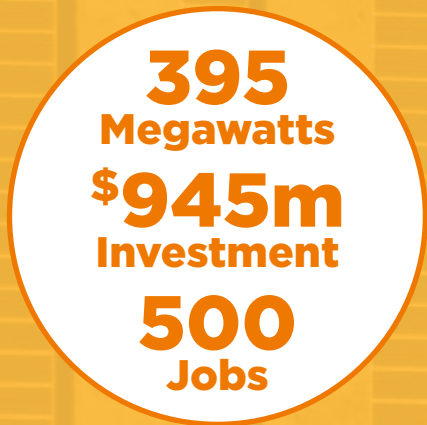




JOBS AND
INVESTMENT
IN RENEWABLE
ENERGY
BY STATE

THE CONSTRUCTION BOOM FOR LARGE-SCALE RENEWABLE ENERGY PROJECTS

(PROJECTS UNDER CONSTRUCTION OR FINANCIALLY COMMITTED)



* As at 15 March 2019

LE

45
Megawatts
33m
Investment
70
Jobs

4941
Megawatts
\$10,003m
Investment
4681
Jobs

3800
Megawatts
\$4714m
Investment
2320
Jobs

3140
Megawatts
\$5034m
Investment
2894
Jobs

D

ISW

TAS

TOTALS

14,841
Megawatts

\$24.5b
Investment

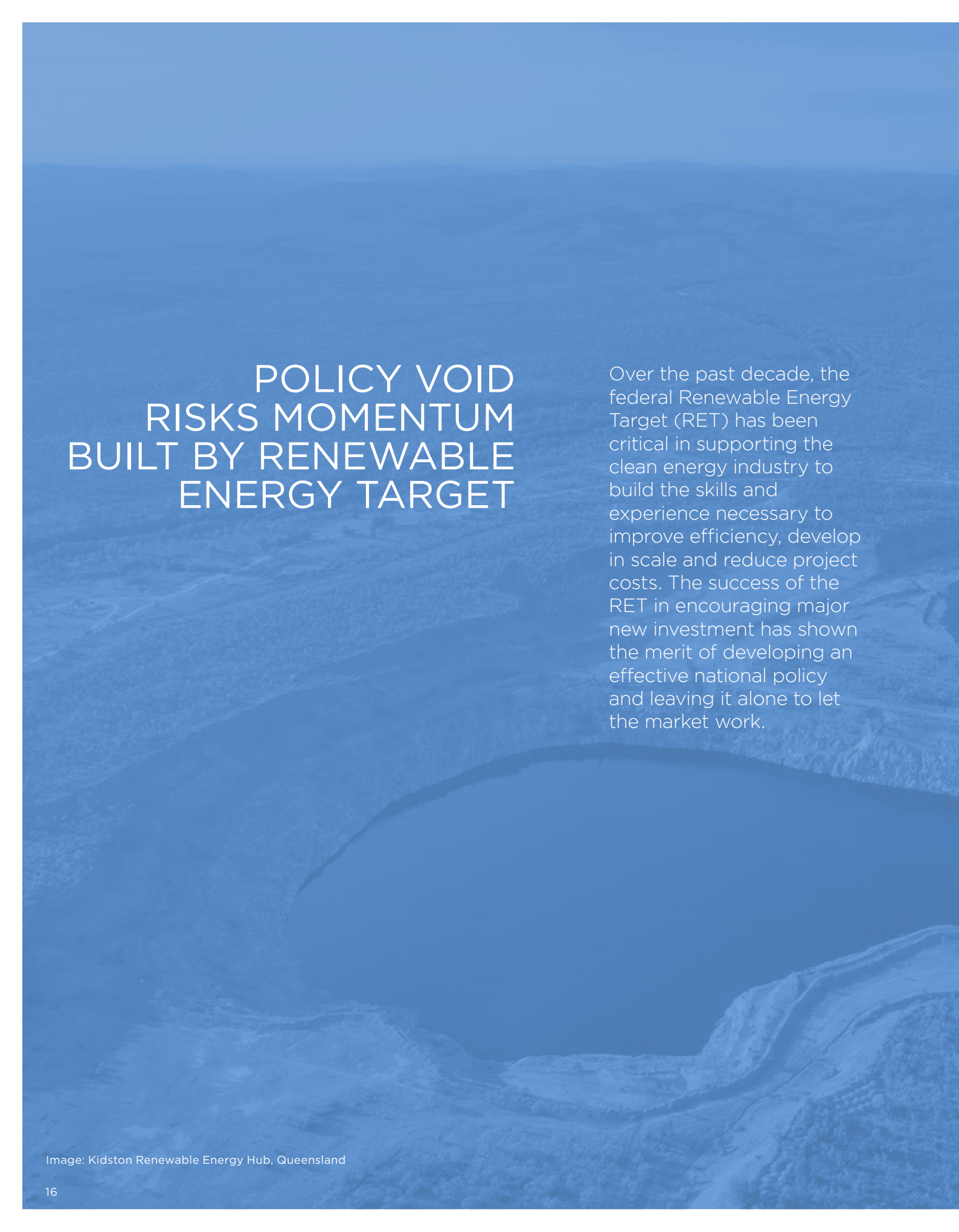
13,233
Jobs

PROJECT TRACKER

RENEWABLE ENERGY PROJECTS COMPLETED IN 2018

TECH	STATE	OWNER	PROJECT	CAPACITY (MW)
Wind	NSW	Partners Group and CWP Renewables	Sapphire Wind Farm	270
Wind	QLD	RATCH	Mt Emerald Wind Farm	181
Solar	NSW	Neoen	Coleambally Solar Farm	150
Wind	VIC	ACCIONA	Mt Gellibrand - Stage 1	138
Solar	QLD	APA Group	Darling Downs Solar Farm	138
Solar	QLD	FRV	Clare Solar Farm	128
Solar	QLD	Sun Metals	Sun Metals Solar Farm	124
Wind	NSW	Infigen Energy	Bodangora Wind Farm	113
Solar	VIC	Foresight Solar	Bannerton Solar Farm	110
Solar	VIC	Wirsol Energy	Wemen Solar Farm	110
Solar	QLD	Lighthouse Solar	Emerald Solar Park	90
Solar	QLD	Edify Energy	Whitsunday Solar Farm	69
Solar	QLD	Edify Energy	Hamilton Solar Farm	69
Solar	NSW	Neoen	Parke Solar Farm	66
Solar	VIC	Wirsol Energy and Edify Energy	Gannawarra Solar Farm - Stage 1	60
Solar	NSW	First Solar	Manildra Solar Farm	56
Wind	VIC	Tilt Renewables	Salt Creek Wind Farm	54
Solar	QLD	Genex	Kidston Solar Project - Stage 1	50
Wind	QLD	Windlab and Erusus Energy	Kennedy Energy Park - Wind	43.5
Solar	NSW	Neoen	Griffith Solar Farm	36
Wind	VIC	Windlab	Kiata Wind Farm	31
Wind	VIC	Pacific Hydro	Yaloak South Wind Farm	29
Solar	NSW	Neoen	Dubbo Solar Hub	29
Bioenergy	QLD	MSF Sugar	Tableland Sugar Mill	24
Solar	WA	APA Group	Emu Downs Solar Farm	20
Solar	QLD	Overland Sun Farming	Hughenden Solar Farm	20
Solar	VIC	Impact Investment Group/Australian Solar Group	Swan Hill Solar Farm	19
Solar	QLD	Canadian Solar	Longreach Solar Farm	17
Solar	QLD	Windlab and Erusus Energy	Kennedy Energy Park - Solar	15
Solar	QLD	Conergy	Lakeland Solar and Storage Project	13
Solar	QLD	Ydot Projects	Dunblane Solar Farm	11
Solar	NSW	New Gullen Range Wind Farm	Gullen Range Solar Farm	10
Solar	WA	Carnegie/Lend Lease	Northam Solar Farm	10
Wind	VIC	BayWa r.e.	Maroona Wind Farm	7
Solar	SA	SSE Australia	Whyalla Solar Farm - Stage 1	6
Solar	QLD	Epho	Brisbane Airport	6
Solar	SA	Renew Power Group	Peterborough Solar Farm	5
Solar	QLD	Canadian Solar and Scouller Energy	Normanton Solar Farm	5

Image: Griffith Solar Farm, New South Wales



POLICY VOID RISKS MOMENTUM BUILT BY RENEWABLE ENERGY TARGET

Over the past decade, the federal Renewable Energy Target (RET) has been critical in supporting the clean energy industry to build the skills and experience necessary to improve efficiency, develop in scale and reduce project costs. The success of the RET in encouraging major new investment has shown the merit of developing an effective national policy and leaving it alone to let the market work.

As the RET nears its 2020 end date and with no federal policy to replace it, fears remain that all the momentum the industry has built will be lost. The Clean Energy Council's December Clean Energy Outlook surveyed approximately 60 senior executives representing businesses with a combined net worth of more than \$17 billion. This group confirmed that while confidence was high in the short term, the lack of federal energy and climate policy continued to rate as an area of high concern.

While clean energy investment does not need new subsidies, it does require long-term energy policy certainty. The decade-long failure of successive federal governments to implement a lasting national energy policy is being

borne out through the high energy prices paid by Australian consumers and businesses, and a series of ad hoc, and largely ineffective, government interventions attempting to reduce them.

Thankfully, states and territories have stepped in to fill the void with their own initiatives to encourage jobs and investment in new clean energy. But the imperative for coordinated policy at the federal level is becoming urgent, as the need to reduce emissions and address climate change becomes increasingly compelling.

Federal Labor has promised more ambition on climate and renewables than the status quo. A proposed target of 50 per cent renewable energy by 2030 would provide a strong market

signal for investors. Whether new investment is driven by the states or the Commonwealth will depend on the Federal Election outcome and the goodwill of all sides of politics to finally deliver a bipartisan solution.

The Council of Australian Governments Energy Council remains the key forum for building consensus on a national energy strategy, but in 2018, voting was often divided along party lines. However, NSW Energy Minister, Don Harwin – a member of the Liberal Party – could not contain his frustration when he branded his federal colleagues “out of touch”⁵ ahead of the December meeting.

5 K Nguyen, B Wylie and C Briggs, ABC News, *Morrison climate policy out of touch says NSW energy minister*, 19 December 2018, <https://www.abc.net.au/news/2018-12-19/morrison-climate-policy-out-of-touch-says-nsw-energy-minister/10633474>

SMALL-SCALE RENEWABLE ENERGY

1.55 GW

of rooftop solar installed across Australia in 2018

2 M+

homes with rooftop solar

\$540

average saving on a yearly power bill



Image: Rooftop solar installation, Victoria

It was another record-breaking year for rooftop solar in 2018, with 1.55 GW installed in the small-scale market across Australia. This was a substantial increase on the previous high of almost 1.1 GW of rooftop solar installed in 2017.

In early December, the industry celebrated another milestone, with the number of households enjoying the benefits of rooftop solar topping 2 million. NSW recorded the highest number of annual installations, increasing from 43,113 households in 2017 to 58,324 in 2018.

With an average solar household saving approximately \$540 every year on their power bills, it's no wonder that consumers are choosing to invest in rooftop solar. Systems are also getting larger, with the average system installed now 7.13 kW, a substantial increase from the 1.34 kW average system installed back in 2009.

A series of new state government programs suggest that 2019 will again eclipse the records set in 2018. An example of this is the Victorian Government's Solar Homes Package, which extends the solar incentive to renters and offers eligible consumers interest free loans – making it even more affordable to add rooftop solar.

This is good news for solar installers and electricians looking to reskill. In 2018, the rooftop solar industry was responsible for 6267 FTE jobs, and a large proportion of these were accredited by the Clean Energy Council. There were 5864 accredited installers at the end of 2018, and this number is expected to rise sharply in 2019. States with strong policy commitments to household rooftop solar and batteries increasingly require installers to be accredited for customers to be eligible for the relevant government rebates.

SMALL-SCALE SOLAR RECORDS BROKEN IN 2018⁶

Record capacity registered in a month

177 MW (November)

Record capacity registered in a week

62 MW (w/c 17 December)

Record average system size in a month

7.7 kW (December)

Record commercial volume in a month

55 MW (December)

Record proportion of STC volume that was commercial

35 per cent (June)

Record monthly volume in states

WA (December), NSW, SA and VIC (November)

Record year in states (number of installs)

QLD, NSW, SA, VIC, WA, ACT and NT

⁶ Sunwiz, 2018 - Australian Solar's record-smashing year. In eye-watering charts, <http://www.sunwiz.com.au/index.php/2012-06-26-00-47-40/73-newsletter/441-2018-australian-solar%E2%80%99s-record-smashing-year-in-eye-watering-charts.html>

LARGE-SCALE RENEWABLE ENERGY

87

large-scale projects under construction or financially committed at the end of 2018

567,828

solar modules installed at Neoen's 150 MW Coleambally Solar Farm

10,800+

jobs created from large-scale renewable construction in 2018



Image: Walkaway Wind Farm, Western Australia

The boom in large-scale renewable energy construction in 2018 shows no sign of slowing down in the year ahead, with large-scale solar projects leading the charge.

A total of 87 large-scale projects were under construction or financially committed at the end of 2018.

An average of more than two large-scale solar farms (over 5 MW) were commissioned each month in 2018, adding 1442 MW of new capacity.

Projects are getting larger and more efficient, which is helping to reduce costs. Neoen's 150 MW Coleambally Solar Farm, completed in October, boasts a record 567,828 solar PV modules, claiming the mantle of the largest fully operational solar farm in Australia – for now.

Wind also prospered in 2018, with nine new wind farms commissioned, including the 270 MW Sapphire Wind Farm in NSW – the state's largest. Another 24 wind farms, with a combined capacity of 5.69 GW, were under construction or financially committed at the end of 2018.

With so many projects in development, competition will remain high for construction resources and workers, which is great news for the regional areas where most projects are based. More than 10,800 direct jobs were created from the large-scale renewable energy construction boom in 2018 – with another 3000 in operations and maintenance. The indirect benefits of these jobs and investment include increased demand for accommodation and services in regional towns.

To meet demand, industry will put an increased focus on skills and training, as well as continue to try to lure workers from the construction and traditional energy industries.

These record levels of activity will also require the Clean Energy Council to continue working with the Australian Energy Market Operator and others to streamline regulatory arrangements and connection processes. The need for new transmission infrastructure to service new renewable energy projects also presents unique challenges for the pace of large-scale renewable development.



Image: Hornsdale Wind Farm, South Australia

STATE POLICIES

Most state governments have worked to fill the void left by the absence of a national climate and energy policy. While a strong, consistent national policy remains preferable to navigating a patchwork of individual jurisdictions, state and territory policy measures have been crucial in driving new investment. State government investment is also supporting innovative renewable energy project trials, making solar more accessible for medium- and low-income households and supporting the roll out of large-scale battery storage.





KEY PROGRAMS, POLICIES AND INITIATIVES

- 100% clean energy by 2020
- Zero net emissions by 2045
- Transition to Zero Emissions Vehicles Action Plan

The ACT has the most ambitious renewable energy target in the country and remains on track to deliver on its goal of 100 per cent clean energy, well before its 2020 deadline. By the end of 2018, nearly 78 per cent of Canberra's electricity came from renewable sources.⁷ It has also set a nation-leading target to achieve zero net greenhouse gas emissions by 2045.

The government continues to roll out programs as part of its 2011-20 *Sustainable Energy Policy*,⁸ which includes the nation's first reverse auction scheme for renewable energy.

The last project to be built under the scheme was Union Fenosa's Crookwell 2 Wind Farm, which was officially opened in November 2018.

The Transition to Zero Emissions Vehicles Action Plan states the ACT Government's newly-leased fleet passenger vehicles will be zero emissions by 2021. Electric vehicle charging infrastructure will be incorporated into new multi-unit and mixed-use developments, and incentives will be offered to increase the uptake of electric bikes in place of cars.⁹

⁷ K Burgess, Canberra Times, *The cost on your power bill of the ACT's switch to renewable energy*, 3 December 2018, <https://www.canberratimes.com.au/politics/act/the-cost-on-your-power-bill-of-the-act-s-switch-to-renewable-energy-20181130-p50jdg.html>

⁸ ACT Government, *ACT Sustainable Energy Policy: 2011-2020*, September 2011, https://www.environment.act.gov.au/__data/assets/pdf_file/0003/581664/EDS_ACT_Sustainable_Energy_Policy_FA_web_A.PDF

⁹ Cities Power Partnership, *Councils take top gong at national climate awards*, 19 October 2018, <https://citiespowerpartnership.org.au/2018/10/19/councils-take-top-gong-at-national-climate-awards/>



77%
of the ACT's electricity
came from renewable
sources in 2018



Image: Ararat Wind Farm, Victoria



KEY PROGRAMS, POLICIES AND INITIATIVES

- Zero net emissions by 2050
- Climate Change Fund Strategic Plan to increase renewable capacity to 10,000 MW by 2021
- Transmission Infrastructure Strategy to improve access and develop poles and wires
- \$55 million Emerging Energy Program to support the commercialisation of dispatchable technology

Unlike many other states, New South Wales does not have a renewable energy target to support large-scale renewable energy development. In 2018, the amount of electricity generation from renewables in NSW was 15 per cent (or 10,355 GWh), behind all states except Queensland.

The state's target of zero net emissions by 2050 has helped to drive other policy initiatives, such as the government's Climate Change Fund Strategic Plan, which aims to double

the state's level of renewable energy capacity to more than 10,000 MW by 2021. In 2018, the government also announced that all 24 goals set out as part of its Renewable Energy Action Plan had been realised.¹⁰

Programs such as the Clean Energy Knowledge Sharing Initiative are leveraging private sector investment to deliver innovative pilot projects.¹¹ The Home Energy Action Program is also helping 4500 vulnerable households to take control of their

energy bills by installing rooftop solar.¹²

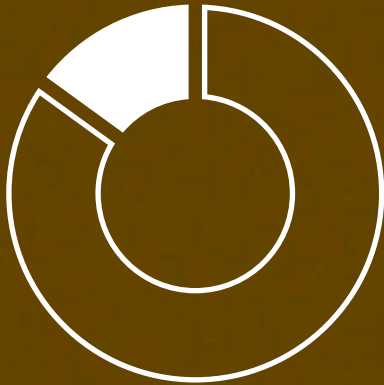
Late in 2018, the government announced the \$55 million Emerging Energy Program to support the commercialisation of dispatchable technology including solar, batteries and pumped hydro. Part of the program will fund pre-investment studies into 24 energy projects – mostly pumped hydro – with a total generation capacity of around 7000 MW on assets owned and operated by WaterNSW.¹³

10 Energy NSW, media release, *NSW plan delivers clean energy results*, 4 December 2018, <https://energy.nsw.gov.au/nsw-plan-delivers-clean-energy-results>

11 Energy NSW, *Clean Energy Knowledge Sharing Initiative*, <https://energy.nsw.gov.au/commercial-business/sustainability/knowledge-sharing-initiative>

12 Energy NSW, media release, *Renters reap benefits of solar revolution*, 6 August 2018, <https://energy.nsw.gov.au/renters-reap-benefits-solar-revolution>

13 WaterNSW, media release, *NSW Government unveils WaterNSW landmark pumped hydro clean energy project*, 12 December 2018, <https://www.waternsw.com.au/about/newsroom/2018/nsw-govt-unveils-waternsw-landmark-pumped-hydro-clean-energy-project>



15%
of NSW's electricity
came from renewable
sources in 2018

A Transmission Infrastructure Strategy announced in November also outlined a plan to develop the poles and wires needed to bring the growing percentage of renewables online.¹⁴

NSW had 24 large-scale energy projects under construction or financially committed at the end of 2018, 17 of which were large-scale solar. The capacity of all these projects is 3467 MW. Energy and Utilities Minister, Don Harwin, said the government had almost 90 large-scale renewable energy projects in its

planning system towards the end of 2018, totalling around 18,500 MW and representing close to \$26 billion in potential investment – the highest on record and enough to power all NSW households.¹⁵

After two years of feasibility studies, Snowy 2.0 was officially approved by the Snowy Hydro board in December 2018 and the Federal Government in February 2019. Upon completion, the project will increase the capacity of the iconic Snowy Hydro Scheme by 2000 MW and provide up to 350,000 MWh

of large-scale energy storage to the National Electricity Market.

In readiness for the state election in March 2019, the Clean Energy Council put out a statement of policy recommendations, including setting a strong target for renewable energy and a reverse auction program similar to that of other states. Both parties made substantive clean energy announcements in mid-February 2019, showing that they have recognised the importance of the issue to voters.¹⁶



Image: Griffith Solar Farm, New South Wales

14 Energy NSW, *Transmission Infrastructure Strategy*, <https://energy.nsw.gov.au/renewables/clean-energy-initiatives/transmission-infrastructure-strategy>

15 Energy NSW, media release, *NSW plan delivers clean energy results*, 4 December 2018, <https://energy.nsw.gov.au/nsw-plan-delivers-clean-energy-results>

16 Clean Energy Council, media release, *Major parties in NSW taking charge on solar and storage ahead of election*, 12 February 2018, <https://www.cleanenergycouncil.org.au/news/major-parties-in-nsw-taking-charge-on-solar-and-storage-ahead-of-election>



KEY PROGRAMS, POLICIES AND INITIATIVES

- 50% renewable energy by 2030
- Roadmap to Renewables report
- Supply and feed-in tariffs under review to encourage behind-the-meter energy storage
- First large-scale solar project approved by the government
- \$5 million program for rooftop solar in schools

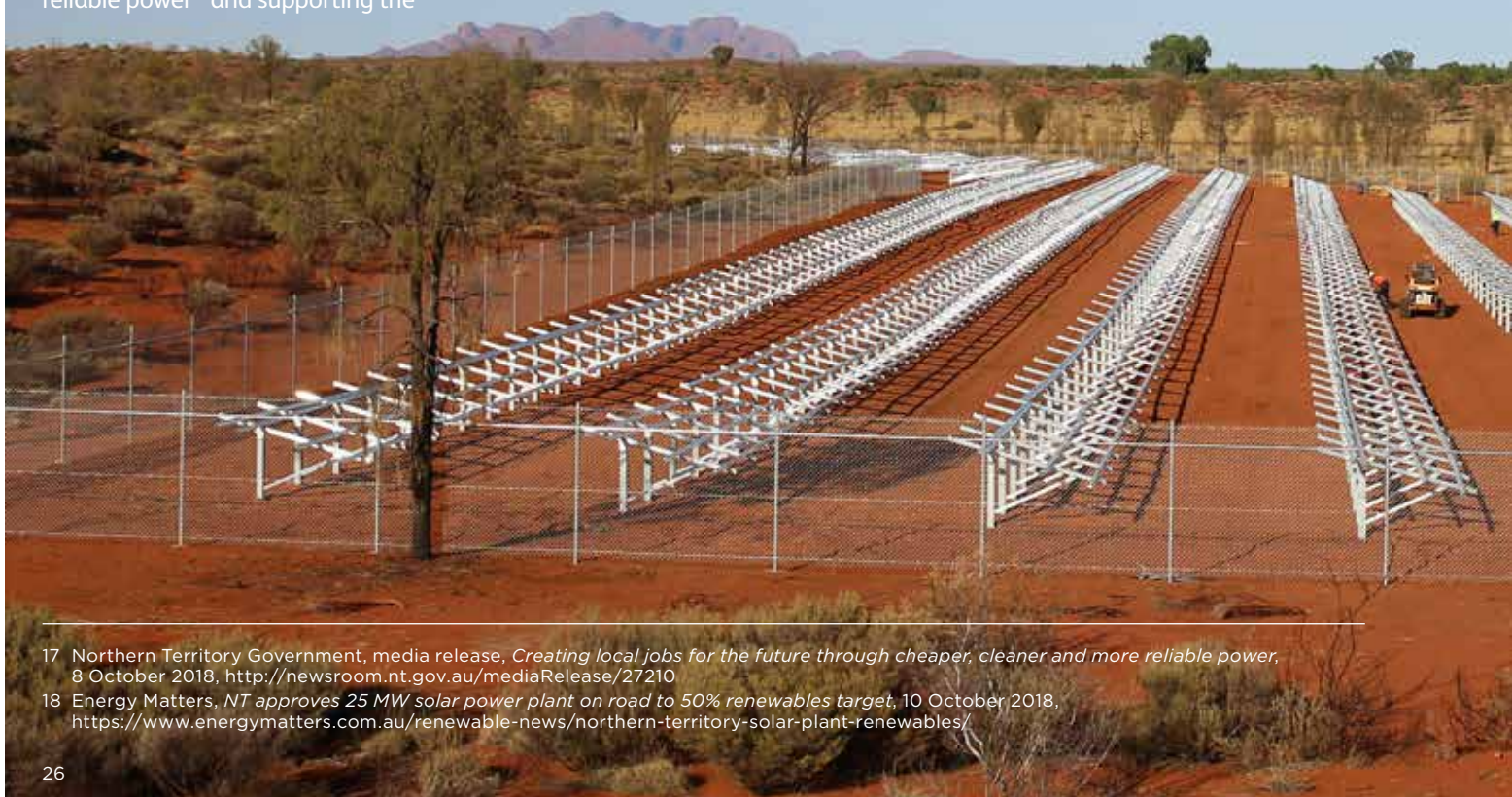
The Northern Territory Government has set itself a target of 50 per cent renewables by 2030.

Following the release of its Roadmap to Renewables report in late 2017, the government has taken several steps to lift the territory's use of clean energy, including initiating electricity market reforms to enhance the delivery of lower-cost and reliable power¹⁷ and supporting the

construction of the \$8.3 million 5 MW Alice Springs Battery Energy Storage System through government-owned corporation, Territory Generation.

A review of supply and feed-in tariffs is underway to encourage behind-the-meter energy storage for those with rooftop solar and stimulate greater take-up of energy efficient technologies.

In October, the government approved the territory's first large-scale solar project near Katherine. The 25 MW solar plant is a joint development by Australian company Epuron and Island Green Power. Government-owned utility, Jacana Energy, will buy energy from the solar plant under a long-term power purchase agreement.¹⁸ A \$5 million program also supports the uptake of rooftop solar in NT schools.



¹⁷ Northern Territory Government, media release, *Creating local jobs for the future through cheaper, cleaner and more reliable power*, 8 October 2018, <http://newsroom.nt.gov.au/mediaRelease/27210>

¹⁸ Energy Matters, *NT approves 25 MW solar power plant on road to 50% renewables target*, 10 October 2018, <https://www.energymatters.com.au/renewable-news/northern-territory-solar-plant-renewables/>

25 MW

solar plant to be constructed
near Katherine



Image: Yulara Solar Project, Northern Territory

KEY PROGRAMS, POLICIES AND INITIATIVES

- 50% renewable energy by 2030
- \$1.16 billion Powering Queensland Plan
- Solar Farm Guidelines delivered in 2018
- \$97 million for solar and energy-saving devices in schools

Queensland was the renewable energy construction capital of Australia in 2018, with more than a third of projects commissioned in 2018 located in the Sunshine State. This is in keeping with the Queensland Government's target of 50 per cent renewable energy by 2030, which was reaffirmed in 2018 through the \$1.16 billion Powering Queensland Plan.¹⁹

Large-scale solar projects are driving this growth, which are being supported by the Queensland Government's Solar 150 program – a commitment to support up to 150 MW of solar power generation in Queensland.²⁰

Of the 38 large-scale renewable energy projects completed across Australia in 2018, 17 were in Queensland. These completed projects added 1004 MW of new capacity and more than 2030 new jobs during construction. Of the 87 large-scale solar projects that are under construction or financially

committed nationwide, 26 per cent are in Queensland, highlighting the rapid pace of the industry's expansion. To help manage this, the government delivered its Solar Farm Guidelines in 2018, which are designed to ensure that large-scale solar projects maintain a strong social licence to operate. The Clean Energy Council and the wider industry contributed to the development of these guidelines.

There was big news in wind too, with construction beginning on the 453 MW Coopers Gap Wind Farm, located about 250 km west of Brisbane. Developed by AGL, the wind farm will produce approximately 1,510,000 MWh of renewable energy annually, making it one of Australia's largest.

It was also a big year for small-scale solar in Queensland, with 54,201 systems installed in 2018 – nearly 150 systems per day. Six of the nation's top ten solar postcodes were again

in Queensland. The government also committed \$97 million over three years to install solar panels and other energy-saving devices in the state's schools.²¹

Queensland also made progress in energy storage, offering low interest loans and grants to households and businesses looking to install solar and/or battery systems²² and announcing the nation's first battery storage database to enable network operators to better manage demand peaks.

The new government-owned energy generator CleanCo got a step closer, with a mandate to deliver 1000 MW of renewable energy, focusing on flexible dispatchable generation.²³

Overall, this activity helped deliver 6206 GWh of renewable energy generation in 2018, or 9.5 per cent of total generation – an increase of 1.5 per cent on the previous year.

19 Department of Energy and Water Supply, *Powering Queensland Plan: an integrated energy strategy for the state*, <https://www.dnrme.qld.gov.au/energy/initiatives/powering-queensland>

20 Business Queensland, *Solar 150 - Queensland's large-scale solar investment program*, <https://www.business.qld.gov.au/industries/mining-energy-water/energy/renewable/projects-queensland/solar-150>

21 Queensland Government, media release, *Solar panels on school roofs to save more than \$10 million a year*, 13 March 2018, <http://statements.qld.gov.au/Statement/2018/3/13/solar-panels-on-school-roofs-to-save-more-than-10-million-a-year>

22 Queensland Government, media release, *Battery grants drive next renewable wave*, 18 November 2018, <http://statements.qld.gov.au/Statement/2018/11/18/battery-grants-drive-next-renewable-wave>

23 Queensland Government, media release, *CleanCo to make power bills cheaper*, 30 August 2018, <http://statements.qld.gov.au/Statement/2018/8/30/cleanco-to-make-power-bills-cheaper>



9.5%

of Queensland's electricity came from renewable sources in 2018

CASE STUDY

SUNSHINE STATE EMBRACES RENEWABLE ENERGY ON A GRAND SCALE



Coal mining and investment may have snared a lot of the headlines in 2018, but there's a big story shaping up about Queensland's growing appetite for large-scale clean energy projects, with North Queensland and the Darling Downs leading the charge.

The largest project to begin construction in North Queensland in 2018 was the first stage of Pacific Hydro's Houghton Solar Farm, located 60 km south-west of Townsville. Once completed, the site will house approximately 1 million solar panels with a generating capacity of up to

500 MW - enough to power around 170,000 homes.

It follows Genex Power's \$1 billion project to convert the Kidston Goldmine, 400 km inland of Townsville, into 250 MW of pumped hydro supported by 270 MW of solar and 150 MW of wind. This would make Kidston the first project in the world to combine pumped hydro with large-scale solar and wind. Stage 2 of the project secured a \$516 million loan from the federal government's Northern Australia Infrastructure Fund in June, putting it on track to commence the next phase of construction in 2019.

In another world first, the 1.5 GW Harlin Solar Farm, announced in May 2018, will stretch across a 2055 hectare site east of Harlin, which is near Ipswich in the state's south-east. The proposal, by Sunshine Energy Markets, was given conditional approval by the local council in November 2018.

In the Darling Downs, construction is underway on AGL's Coopers Gap Wind Farm, an \$850 million project

developed with investment from the company's Powering Australia Renewables Fund. Due to be completed in 2019, Coopers Gap will have a capacity of 453 MW and produce around 1,510,000 MWh of renewable energy, making it one of the country's largest wind farms.

In Central Queensland, Pacific Hydro and Lacour Energy have announced plans to develop a hybrid wind and solar farm at Clarke Creek, 150 km north-west of Rockhampton. While the project is currently in the feasibility phase, if constructed, it will include more than 800 MW of wind generation, up to 400 MW of solar power and a battery energy storage facility.

As the second-largest state by area in Australia, and with some of the best renewable energy resources in the world, it's no surprise that Queensland is increasingly hosting projects on a grand scale.



KEY PROGRAMS, POLICIES AND INITIATIVES

- \$200 million towards an interconnector with New South Wales
- \$180 million household battery program
- \$50 million Grid Scale Storage Fund





53%

of South Australia's electricity came from renewable sources in 2018

The Liberal Party, led by Steven Marshall, was elected to power in March 2018, following 16 years of Labor government in the state. The Liberal Party's election campaign focused on affordability, reliability, better value for taxpayers and stronger connections between South Australia and the National Electricity Market.

Big ticket items included funding of \$200 million towards an interconnector with NSW – allowing the state access to additional electricity when needed and to export

its abundant renewable energy – plus a \$180 million household battery program offering grants to 40,000 South Australian households. In September, the green light was given to German energy storage giant Sonnen to begin assembling and manufacturing its world-leading home battery technology in Adelaide, creating around 430 manufacturing and installation jobs.

The government also launched the \$50 million Grid Scale Storage Fund to accelerate investment in utility-scale energy storage in the state.

Large-scale renewable energy projects announced in the state in 2018 included Infigen Energy's \$38 million lithium-ion battery energy storage system. The 25 MW / 52 MWh battery at Lake Bonney Wind Farm in South Australia's south-east was supported by the South Australian Government and ARENA.

More than half of South Australia's electricity was generated by renewable energy for the first time in 2018, reaching 7152 GWh – 53 per cent of total generation.

KEY PROGRAMS, POLICIES AND INITIATIVES

- **Battery of the Nation plan could double Tasmania's renewable capacity to 5000 MW**
- **Planning continues for two renewable energy parks, which will include wind and battery storage**

Tasmania is close to 100 per cent clean energy, thanks to its extensive hydro power network and a commitment to becoming a net exporter of renewables.

In 2018, 95.9 per cent of the state's generation (11,584 GWh) was provided by renewables, the bulk of which came from hydro power. Hydro Tasmania continues to invest in modernising and upgrading its substantial assets, with a view to becoming the renewable energy battery for Australia.²⁴

The Battery of the Nation plan, supported by ARENA, could double the state's renewable energy capacity from 2500 MW to 5000 MW through pumped hydro storage, wind farms and upgrades to existing hydro power facilities. Early modelling shows that the Battery of the Nation would create billions of dollars of investment

and thousands of jobs in regional Tasmania over 10 to 15 years.²⁵

The plan is dependent on investment in at least one more Bass Strait interconnector to strengthen the links between Tasmania's hydro network and the rest of the National Electricity Market. Analysis released in December confirmed that such a measure could unlock hundreds of megawatts of latent dispatchable capacity in the Tasmanian hydropower system and make it available to a transforming National Electricity Market.²⁶

In February 2019, TasNetworks released its Initial Feasibility Report on the development of a second Bass Strait interconnector, Marinus Link. The report found Marinus Link to be technically feasible and economically viable under a number of plausible scenarios. The release of the report

also coincided with the Federal Government providing \$56 million to fast track the development of the project.²⁷

Wind continues to play an important role in the state's clean energy mix, providing around 10 per cent of generation. In 2018, Goldwind's Cattle Hill Wind Farm commenced construction. The 150 MW project will consist of 48 turbines and is expected to become fully operational in late 2019.²⁸ The 112 MW Granville Harbour Wind Farm, being developed by Vestas, is also due to be operational by the end of 2019. Planning continues for UPC Renewables' 150 MW Jim's Plain and 450 MW Robbins Island renewable energy parks, both of which will include wind and battery storage.

24 Tasmanian Climate Change Office, *Advancing our renewable energy capability*, http://www.dpac.tas.gov.au/divisions/climatechange/tasmanias_climate_change_action_plan_20172021/advancing_our_renewable_energy_capability

25 Hydro Tasmania, media release, *Battery of the Nation - an integral part of national energy planning*, 17 July 2018, <https://www.hydro.com.au/news/media-releases/2018/07/17/battery-of-the-nation---an-integral-part-of-national-energy-planning>

26 Hydro Tasmania, media release, *Unlocking Tasmania's energy capacity through interconnection*, 12 December 2018, <https://www.hydro.com.au/news/media-releases/2018/12/12/unlocking-tasmanias-energy-capacity-through-interconnection>

27 Australian Renewable Energy Agency, media release, *Prime Minister commits \$56 million to Marinus Link progress*, 25 February 2019, <https://projectmarinus.tasnetworks.com.au/2019/02/initial-feasibility-report-released/>

28 Goldwind, *Cattle Hill Wind Farm*, <http://www.cattlehillwindfarm.com/>



95.9%
of Tasmania's electricity
came from renewable
sources in 2018



Image: Catagunya Power Station, Tasmania



KEY PROGRAMS, POLICIES AND INITIATIVES

- 50% renewable energy by 2030
- Zero net emissions by 2050
- \$1.3 billion Solar Homes program to provide support to 720,000 households over 10 years to install solar

Renewable generation in Victoria reached 9908 GWh in 2018, representing a record 20.6 per cent of the state's total generation. Victoria has legislated renewable energy targets of 40 per cent by 2025 and zero net emissions by 2050. In November, the Labor Government committed to extending the target to 50 per cent by 2030, providing additional investment certainty to renewable energy companies.

The incumbent Labor Government went into the November election campaign with a series of new clean energy policies, including the \$1.3 billion Solar Homes program, which will provide support to 720,000 households over 10 years to install solar panels, solar hot water or household storage. Eligible Victorian households can receive a rebate of up to \$2225 to install rooftop solar and pay the remainder back over four years

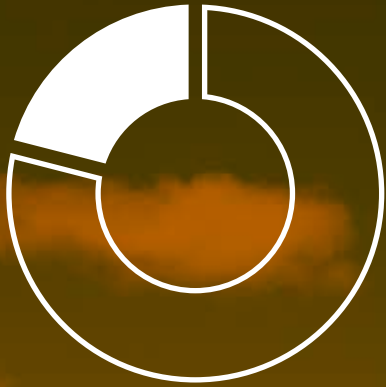
with an interest-free loan. For the first time, the scheme was also extended to renters, who have traditionally been locked out of the benefits of solar. Safety was a priority under the scheme, with rebates only available to customers using Clean Energy Council accredited installers and approved products.

Victorians welcomed the Labor party's ambitious policies in energy and other areas, delivering Labor a landslide victory.

Nine large-scale renewable energy projects were completed in Victoria in 2018, four solar and five wind. The largest of these was stage one of the Mount Gellibrand Wind Farm, which has a capacity of 138 MW.

The Australian Energy Market Operator is currently undertaking a Regulatory Investment Test for Transmission (RIT-T) to assess the

technical and economic viability of increasing transmission network capacity in western Victoria. If approved, the new transmission capacity will unlock more of the state's significant wind resources. A final decision on the RIT-T is expected in mid-2019.



20.6%
of Victoria's electricity
came from renewable
sources in 2018



Image: Portland Wind Energy Project, Victoria



KEY PROGRAMS, POLICIES AND INITIATIVES

- Powerbank trial to integrate a shared battery storage service into the network
- Rooftop solar trading scheme
- 100 kW of solar installed in remote Aboriginal communities

Western Australia's renewable energy generation increased from 14 per cent in 2017 to 16.2 per cent in 2018. In the absence of a renewable energy or zero net emissions target, the state has traditionally lagged behind the others in clean energy development. However, new investment in recent years is now translating to projects on the ground.

The 20 MW Emu Downs Solar Farm north of Perth has been completed

and is a key part of what will become one of the largest wind-solar precincts in the country (at 230 MW) once the 130 MW Badgingarra Wind Farm is complete.²⁹ The Northam Solar Farm also began feeding energy into the grid in 2018, and will supply up to 24,000 MWh every year – enough to power 4000 average households.³⁰

In April, the McGowan Labor Government approved state-owned

energy generator and retailer Synergy's plan to enter into a joint venture with the Dutch Infrastructure Fund and Australian industry super fund Cbus for the development of large-scale renewables projects in Western Australia.³¹ The group will deliver stage two of the Greenough River Solar Farm south of Geraldton, increasing its capacity from 10 MW to 40 MW, as well as the refurbishment



²⁹ G Parkinson, RenewEconomy, *WA's largest solar farm - Emu Downs - opens for business*, 5 March 2018, <https://reneweconomy.com.au/w-a-s-largest-solar-farm-emu-downs-opens-for-business-69933/>

³⁰ S Vorrath, RenewEconomy, *Carnegie's Northam solar farm begins sending energy to the grid in W.A.*, 22 November 2018, <https://reneweconomy.com.au/carnegies-northam-solar-farm-begins-sending-energy-to-the-grid-in-w-a-67530/>

³¹ WA Government, media release, *New renewables projects in WA given green light*, 10 April 2018, <https://www.mediastatements.wa.gov.au/Pages/McGowan/2018/04/New-renewables-projects-in-WA-given-green-light.aspx>



16.2%
of WA's electricity
came from renewable
sources in 2018

of Albany Grasmere Wind Farm. It will also scope the development of an additional renewable energy project at the Warradarge Wind Farm.

A number of renewable energy pilot projects supported by the WA Government were announced in 2018, including the Australian-first PowerBank trial, which will integrate a shared battery storage service into the network.³² Other projects include a

rooftop solar trading scheme, 100 kW of solar installed in remote Aboriginal communities³³ and support for a 1 MW solar farm and 1 MW battery storage system to provide clean energy to the coastal town of Onslow in the Pilbara.³⁴

WA premier Mark McGowan said the government's demonstrated support for renewables indicated there was no need to introduce a renewable energy target.³⁵



Image: DeGrussa Solar Project, Western Australia

32 WA Government, media release, *PowerBank trial to revolutionise bulk battery storage in WA homes*, 17 October 2018, <https://www.mediastatements.wa.gov.au/Pages/McGowan/2018/10/PowerBank-trial-to-revolutionise-bulk-battery-storage-in-WA-homes.aspx>

33 WA Government, media release, *Lower electricity bills for Aboriginal communities installing solar*, 9 November 2018, <https://www.mediastatements.wa.gov.au/Pages/McGowan/2018/11/Lower-electricity-bills-for-Aboriginal-communities-installing-solar.aspx>

34 WA Government, media release, *Onslow microgrid project Stage One completed*, 3 July 2018, <https://www.mediastatements.wa.gov.au/Pages/McGowan/2018/07/Onslow-microgrid-project-Stage-One-completed.aspx>

35 B Shepherd, ABC News, *WA losing Australia's renewable energy race, Climate Council report finds*, 16 October 2018, <https://www.abc.net.au/news/2018-10-16/wa-falling-behind-in-generation-of-renewable-energy/10384104>

EMPLOYMENT

3000

construction jobs created in Port Augusta thanks to 13 renewable energy projects

6267

FTE jobs attributable to the rooftop solar industry in 2018

16%

increase in the number of CEC accredited installers in 2018



Image: Hornsdale Wind Farm, South Australia

A record year in renewable energy investment also brought with it a jobs boom, with 10,850 construction jobs and approximately 3000 operations and maintenance jobs across the sector. That's already more than the number of jobs in fossil fuel electricity generation.³⁶

Renewable energy investment is not only bringing with it project-level jobs, it's helping the transformation of some fossil fuel-dependent industries and regions. On the back of its \$200 million investment in a large-scale solar farm, Sun Metals was able to announce the \$300 million expansion of its zinc refinery in Townsville, creating an additional 827 jobs in construction alone.³⁷ Port Augusta, a region once on the brink from the closure and near collapse of its local coal and steel plants, is now home to 3000 construction and 200 ongoing jobs, thanks to 13 renewable energy projects

in various stages of development.³⁸ Similarly, the outback city of Whyalla aims to more than treble its population within the next 10 to 20 years³⁹ thanks to billionaire Sanjeev Gupta's ambitious plan to upgrade the steelworks, powered by 1 GW of renewable energy.⁴⁰

Rooftop solar is also seeing jobs growth for installers, with the industry responsible for 6267 FTE jobs in 2018. The number of Clean Energy Council accredited installers increased by 16 per cent in 2018 to reach 5864 – the largest number of accredited installers ever. Queensland has the highest

³⁶ G M Farr, news.com.au, *Renewable energy could offer up to 60,000 Australian jobs*, 21 November 2018, <https://www.news.com.au/finance/work/careers/renewable-energy-could-offer-up-to-60000-australian-jobs/news-story/18ddf975618ae782fc94aa39b763dcfb>

³⁷ S Vorrath, RenewEconomy, *"No need for new coal:" Sun Metals formally opens solar farm in "George" town*, 17 August 2018, <https://reneweconomy.com.au/no-need-for-new-coal-sun-metals-formally-opens-solar-farm-in-george-town-26798/>

³⁸ A Morton, The Guardian, *Life after coal: the South Australian city leading the way*, 20 July 2018, <https://www.theguardian.com/environment/2018/jul/20/life-after-coal-the-south-australian-city-leading-the-way>

CASE STUDY
FEMALE LEADERSHIP HIGH ON THE AGENDA



Images:
 Left: Allison Hawke
 Right: Heidi Sick

The Clean Energy Council continued to strengthen its commitment to gender diversity in the clean energy industry in 2018 through its Women in Renewables initiative.

The program empowers women and builds a community of like-minded advocates, so that they, and the sector, can thrive.

Now in its fourth year, the Women in Renewables Australian Institute of Company Directors (AICD) Scholarship supports a female employee within a Clean Energy Council member company, Approved Solar Retailer or an Accredited Installer to undertake

the AICD Foundations of Directorship course.

The 2019 scholarship was awarded to Allison Hawke, the Chief Operating Officer at ESCO Pacific. Allison has played a key role in the development of the Ross River and Finley Solar Farms.

The Clean Energy Council also partnered with the Monash Business School to offer a second Women in Renewables scholarship in 2018. The *Your Leadership Voice: Women in Focus* program provides female leaders with tools to overcome various workplace barriers, with a focus on communication.

The inaugural recipient, Heidi Sick, is a Section Executive at WSP, where she oversees the diverse and high performing renewable energy team.

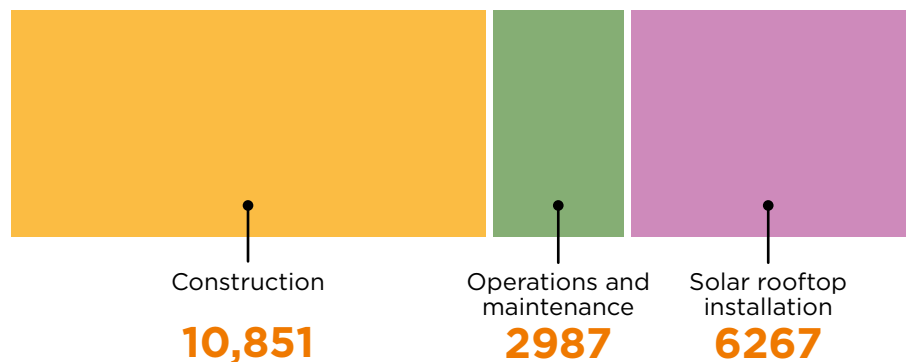
In early 2019, the Women in Renewables initiative also launched its Speakers Guide. An industry first, the guide is designed to showcase the breadth, expertise and knowledge offered by women in the sector to event organisers. Featuring more than 150 women from across the Australian clean energy industry, the guide is an invaluable resource that will further increase gender diversity at clean energy events.

In November, the Clean Energy Council and some members of the network participated in a survey led by the International Renewable Energy Agency on gender challenges in the global industry. The findings from the survey will contribute to addressing the data and knowledge gap on gender in the renewable energy industry.

number of accredited solar installers at 1571, who helped to install more than 54,200 systems across the state in 2018.

The number of accredited installers is expected to rise again in 2019 due to state schemes increasingly requiring the use of accredited installers for customers to obtain rebates on their solar installations. With battery storage rebate programs also rolling out in several states – and potentially nationally if Labor wins the 2019 Federal Election – there will be further training and employment opportunities for installers and electricians.

EMPLOYMENT IN RENEWABLES



39 T Fedorowytch and D Keane, ABC News, *Whyalla population set to boom as billionaire Sanjeev Gupta outlines steelworks vision*, 10 December 2018, <https://www.abc.net.au/news/2018-12-10/whyalla-population-to-boom-as-sanjeev-gupta-embarks-on-upgrades/10599158>

40 G Parkinson, RenewEconomy, *Whyalla steel city goes green with 1GW of solar and storage*, 24 October 2017, <https://reneweconomy.com.au/whyalla-steel-city-goes-green-with-1gw-of-solar-and-storage-92904/>

RENEWABLES FOR BUSINESS

20

corporate PPAs
signed in 2018

Australian businesses finding it difficult to secure affordable long-term contracts for their electricity increasingly turned to renewable energy in 2018 through on-site generation and power purchase agreements (PPAs).

931 MW

contracted for under
corporate PPAs in
Australia in 2018

It's a trend happening across the globe, with figures from Bloomberg New Energy Finance showing that corporate PPAs jumped from 6.1 GW purchased in 2017 to 13 GW in 2018. In Australia, 20 corporate PPAs were signed in 2018, contracting for a total of 931 MW and supporting projects with a total capacity of 2600 MW. The key drivers for buyers were improving price certainty in volatile markets, the potential for energy cost savings, sustainability or renewable energy targets and improving their brand or social licence. Some of the major corporate PPAs signed in 2018 included:

- Carlton & United Breweries signed a 12-year PPA with Karadoc Solar Farm (112 MW) for 74 GWh per annum as part of its 100 per cent renewable energy strategy.

Corporate PPAs have now been signed in a wide range of sectors – led by manufacturing, local councils, universities, utilities and state governments for their own operations or infrastructure projects. Victoria is the leading state, with just under half of the new capacity from corporate PPAs.

However, the corporate PPA sector remains an early-stage market. For renewable energy developers, the search and transaction costs for finding and negotiating with buyers can be high. For many buyers, energy procurement is often not a core function, and understanding and negotiating corporate PPAs can be complex and time-consuming.

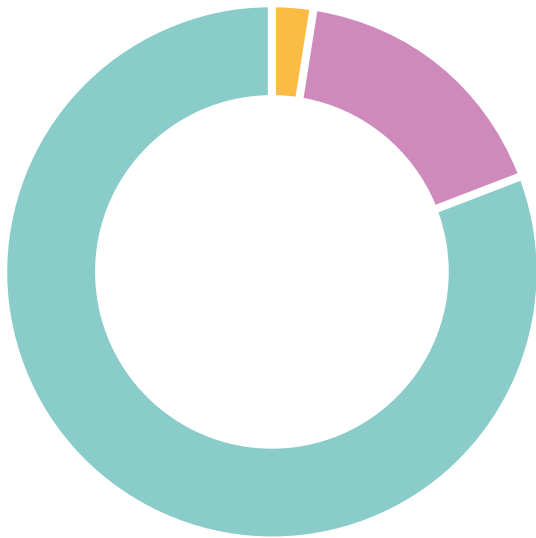
In 2018, the Business Renewables Centre-Australia (BRC-A) was launched to support and facilitate the growth of corporate PPAs. The BRC-A is a member-based organisation – the Clean Energy Council is a founding member – which will help connect buyers and sellers (through a marketplace platform where developers can promote their project) and help buyers learn about corporate PPAs through information resources, tools, training bootcamps and events. The BRC-A is a collaboration between WWF-Australia (building on the Renewable Energy Buyers Forum), Climate-Kic Australia and the Institute for Sustainable Futures, University of Technology Sydney.

13 GW

of power purchased
through PPAs globally
in 2018

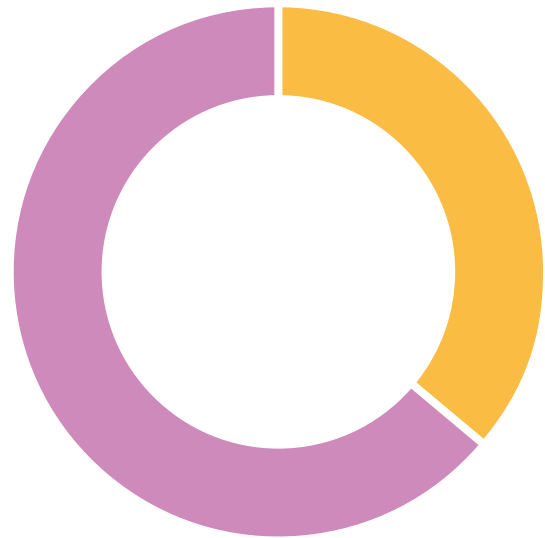
- Bluescope Steel negotiated a seven-year PPA with Finley Solar Farm (133 MW) for 230 GWh per annum.
- The Commonwealth Bank of Australia negotiated a 12-year PPA with CWP Renewables to buy 96 GWh per annum. The majority of the power comes from the Sapphire Wind Farm (270 MW) but will be supplemented from another solar farm or battery to meet a stable baseload requirement.
- Sydney Metro negotiated a 15-year PPA with Beryl Solar Farm (87 MW) for 134 GWh per annum to offset the entire demand of the NorthWest metro project.
- The University of New South Wales negotiated a 15-year PPA for up to 124 GWh per annum with the Sunraysia Solar Farm (200 MW), which was 'sleeved' into its retail agreement with Origin Energy – part of a growing trend for retailer involvement in corporate PPAs.

CORPORATE PPAs BY PROJECT DEVELOPMENT STAGE (MW)⁴¹



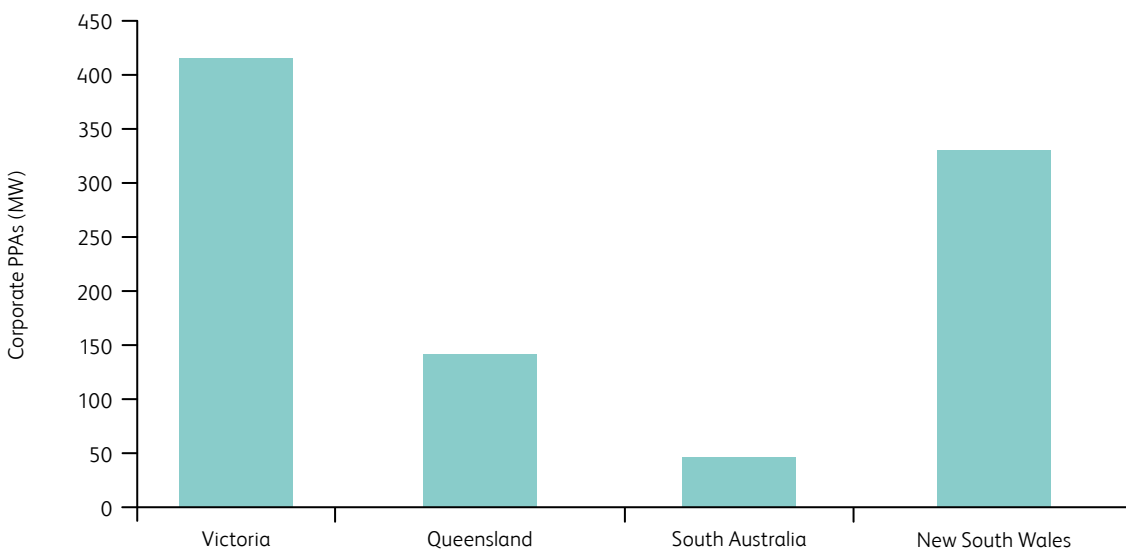
● Operating 24
● Confirmed project 155
● New project 753

CORPORATE PPAs BY TECHNOLOGY TYPE (MW)⁴¹



● Wind 339
● Solar 593

LEADING STATES FOR CORPORATE PPAs (MW)⁴¹



41 Business Renewables Centre-Australia

RENEWABLES FOR BUSINESS CONTINUED

CASE STUDY SOLAR POWERED BEER DELIVERS LIQUID SUNSHINE



Image: Bright Brewery, Victoria

The only way to improve on a deliciously cold beer is to make it from cheap, clean energy, right?

That's the view of a growing number of boutique brewers across Australia who, like many small to medium business owners, have adopted solar power to tackle rising energy costs.

Stomping Ground Brewing Co., in Melbourne's inner north, now generates 60 per cent of its energy onsite with the installation of 357 solar panels on its brewery and beer hall. Installed in February 2018, the 96 kW system generates about 130,000 kWh a year.

In Alpine country in north-east Victoria, Bright Brewery meets all of its energy needs with a 50 kW solar

system. Positioned across 600 square metres of roof, the system uses micro-inverters and the latest smart technology to maximise generating capacity.

In Sydney, Young Henrys brewers used crowdfunding to kick start its investment in a 29.9 kW solar array, while Brisbane's Helios Brewing exports about 40 per cent of its energy back to the grid thanks to its solar PV and solar thermal heating. As part of the company's holistic approach to environmental sustainability, excess brewers' grain is also sent to a local pig farm, reducing waste to landfill.

Larger brewers are also making the switch. Anheuser-Busch InBev, which owns more than 400 global beer

brands, plans to increase its use of renewables for electricity from seven to 100 per cent by 2025. Using a combination of corporate power purchase agreements (PPAs) and on-site solar, the multinational says it is currently well ahead of its 2025 goal.

Carlton & United Breweries (CUB) also announced that it has signed a PPA with German renewable energy company BayWa r.e. to source 74,000 MWh per year for 12 years from the Karadoc Solar Farm in Mildura, Victoria. CUB CEO Jan Craps said certainty of supply and pricing from renewables was crucial in making the switch.

INTERNATIONAL UPDATE

US\$332.1B

global investment
in clean energy in 2018

Global investment in clean energy was US\$332.1 billion in 2018 – down from a record year in 2017. However, much of the decline was due to falling capital costs, with the amount of wind and solar capacity installed around the world actually increasing in 2018. China was again the clear leader, with a total investment of \$100.1 billion. This was down 32 per cent on the previous record year, largely due to a policy shift that saw the government restrict access to its feed-in tariff for new solar projects.

US\$100.1B

Chinese investment
in clean energy in 2018

At US\$64.2 billion, the US was the second-biggest investor. Bloomberg New Energy Finance (BNEF) says developers in the US have been rushing to finance wind and solar projects to take advantage of tax credit incentives before they expire early next decade, lifting investment by 12 per cent.⁴²

BNEF's global benchmark for the cost of installing a megawatt of photovoltaic capacity fell by 12 per cent, helping solar to reach a record 109 GW of capacity globally in 2018.

109 GW

global solar
capacity in 2018

Corporate PPAs are also driving new investment, with global tech giants leading the way. Facebook sourced 2.6 GW of renewable energy from PPAs globally in 2018, which is more than the entire Asia-Pacific region combined. In the US, Facebook, Google and Amazon have a combined market share of 35.1 per cent of PPA-driven investment.⁴³

GLOBAL RENEWABLE ENERGY INVESTMENT BY TECHNOLOGY⁴⁴



WIND

UP 3%
US\$128.6 BILLION



GEOHERMAL

UP 10%
US\$1.8 BILLION



SOLAR

DOWN 24%
US\$130.8 BILLION



SMALL HYDRO

DOWN 50%
US\$1.7 BILLION



BIOMASS AND WASTE-TO-ENERGY

UP 18%
US\$6.3 BILLION



MARINE

UP 16%
US\$180 MILLION

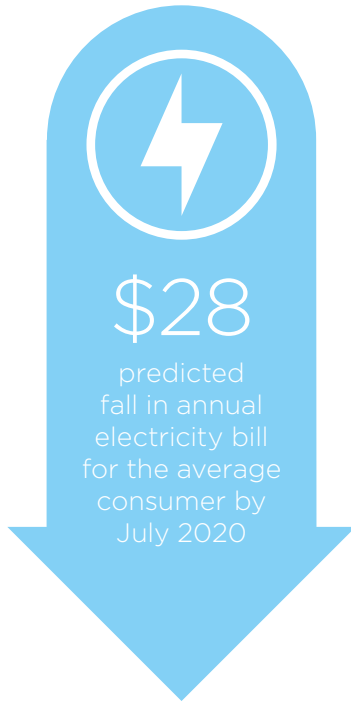
42 V Henze, Bloomberg New Energy Finance, *Clean energy investment exceeded \$300 billion once again in 2018*, 16 January 2019, <https://about.bnef.com/blog/clean-energy-investment-exceeded-300-billion-2018/>

43 ReNews, *Tech giants 'lead US corporate PPA charge'*, 4 February 2019, <https://renews.biz/51304/tech-giants-lead-us-corporate-ppa-charge/>

44 V Henze, Bloomberg New Energy Finance, *Clean energy investment exceeded \$300 billion once again in 2018*, 16 January 2019, <https://about.bnef.com/blog/clean-energy-investment-exceeded-300-billion-2018/>

ELECTRICITY PRICES

Electricity prices remained a politically charged issue in 2018, and this is likely to continue as the nation heads into a Federal Election in May.



Considering the amount of attention given to the issue by politicians and the media, it may come as a surprise to some consumers that retail electricity prices are expected to fall over the next two years.⁴⁵

The Australian Energy Market Commission (AEMC) released its annual report on residential electricity price trends in late 2018 and the news was positive for most consumers, as well as the renewable energy industry.

It showed that average residential electricity prices and bills are expected to decrease between 2019 and 2021, primarily due to lower wholesale costs. This is driven by the 9732 MW of new generation and battery storage entering the National Electricity Market.⁴⁶

The AEMC found that an average consumer will be paying around \$28 less than today by July 2020. The ACT, Western Australia and Northern Territory are exceptions to this national trend, with electricity prices and bills expected to increase slightly over the period.

The AEMC also found the decrease in wholesale costs more than offsets slight

increases in network and environmental policy costs, primarily due to the Small-scale Renewable Energy Scheme. The lowering of wholesale costs is likely to continue, with a report by the Australian Industry Group confirming that new wind and solar projects built under the RET are already starting to reduce wholesale power prices.⁴⁷ This will accelerate as more come online.

The news may be small comfort for most consumers, however, who continue to pay prices well above the historic average. Energy market reform – combined with long-term policy stability – must remain a priority. The Australian Competition and Consumer Commission's (ACCC) review of the retail electricity market, released in July 2018, made 56 recommendations to address what it described as a 'broken National Electricity Market' and bring prices down.⁴⁸ Following its decision to abandon the National Energy Guarantee, the Morrison Government chose to pursue only a handful of the ACCC's recommendations, focusing instead on lowering prices for retail customers and improving reliability. Its

45 Australian Energy Market Commission, media release, *Electricity prices falling overall with variation between jurisdictions*, 21 December 2018, <https://www.datocms-assets.com/6959/1545288360-2018-price-trends-combined-media-release.PDF>

46 Australian Energy Market Commission, media release, *Electricity prices falling overall with variation between jurisdictions*, 21 December 2018, <https://www.datocms-assets.com/6959/1545288360-2018-price-trends-combined-media-release.PDF>

47 Australian Industry Group, *From worse to bad: Eastern Australian energy prices*, p6, July 2018, https://cdn.aigroup.com.au/Reports/2018/AiGroup_Report_Eastern_Australian_Energy_Prices_July_2018.pdf

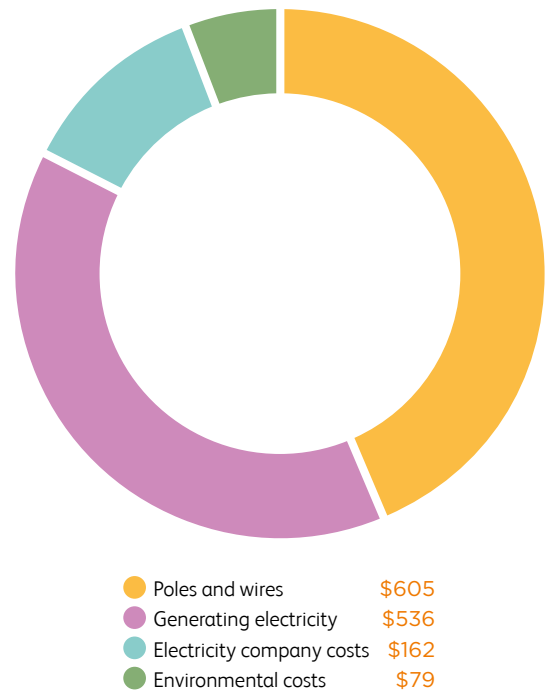
48 Australian Competition and Consumer Commission, media release, *ACCC releases blueprint to reduce electricity prices*, 11 July 2018, <https://www.accc.gov.au/media-release/accc-releases-blueprint-to-reduce-electricity-prices>

pursuit of legislation that would seek to forcibly break up big power companies that refuse to lower prices was subject to widespread condemnation and has subsequently been put on hold, pending the outcome of the Federal Election.

The government also introduced a program which underwrites new investment in 'firm generation' to increase supply. Critics of the policy, including the Clean Energy Council, say the scheme is a twisted version of the ACCC's original recommendation that could create a massive market distortion and further undermine investment confidence.

The industry – and others, including the Business Council of Australia and the Australian Industry Group – has always argued that piecemeal approaches to energy market reform are no substitute for sensible, market-based policy. Without this, consumers reliant on the national grid will be waiting a while longer to see a more substantial reduction in their energy bills.

WHAT MAKES UP YOUR POWER BILL, 2017-18⁴⁹



⁴⁹ Australian Energy Market Commission, *Residential electricity price trends 2018 – National Fact Pack*, 21 December 2018, <https://www.aemc.gov.au/sites/default/files/2018-12/National%20fact%20pack.pdf>

TRANSMISSION

Geographically dispersed renewable generation is placing a greater reliance on the role of the transmission network.

The current transmission system was developed to connect large conventional generators to demand centres. As smaller but more numerous renewables generators are installed at the peripheries of the transmission network to take advantage of higher quality solar and wind resources, there is a need to increase the capability of the transmission system to reduce congestion and enhance power system flexibility and security.

In July 2018, the Australian Energy Market Operator released its first Integrated System Plan (ISP), which provides an integrated pathway for the development of the transmission system for the National Electricity Market over the next 20 years. The ISP identified three tranches of transmission investment, ranging from immediate requirements – such as increasing transfer capability between NSW, Queensland and Victoria – to longer-term developments such as strengthening the SnowyLink interconnection between Victoria and NSW.

The ISP also identifies and prioritises Renewable Energy Zones (REZs), areas where high quality renewable resource overlaps with locations where the transmission network is strong and there

is good network capacity available. It considers how to best develop REZs in the future that are optimised with necessary transmission developments.

While the ISP outlines a pathway for transmission development, there is still a need to turn that plan into action. The Energy Security Board released a series of recommendations in December 2018 to 'action the ISP'. These included setting up two funds to underwrite expenditures on immediately needed projects and for shared connections costs for REZs, making several improvements to future ISPs to make them investment grade, exploring industry concerns around connections, access and congestion (which the Australian Energy Market Commission is also considering concurrently) and regulatory improvements to fast-track certain transmission projects.

There are also several regulatory approval processes underway for transmission upgrades and new interconnectors. These include minor upgrades to existing interconnectors between Victoria and NSW and Queensland and NSW, significant upgrades to the Western Victoria network and new interconnectors between SA and NSW and Tasmania and Victoria.

Governments also recognised the importance of transmission for the energy transformation:

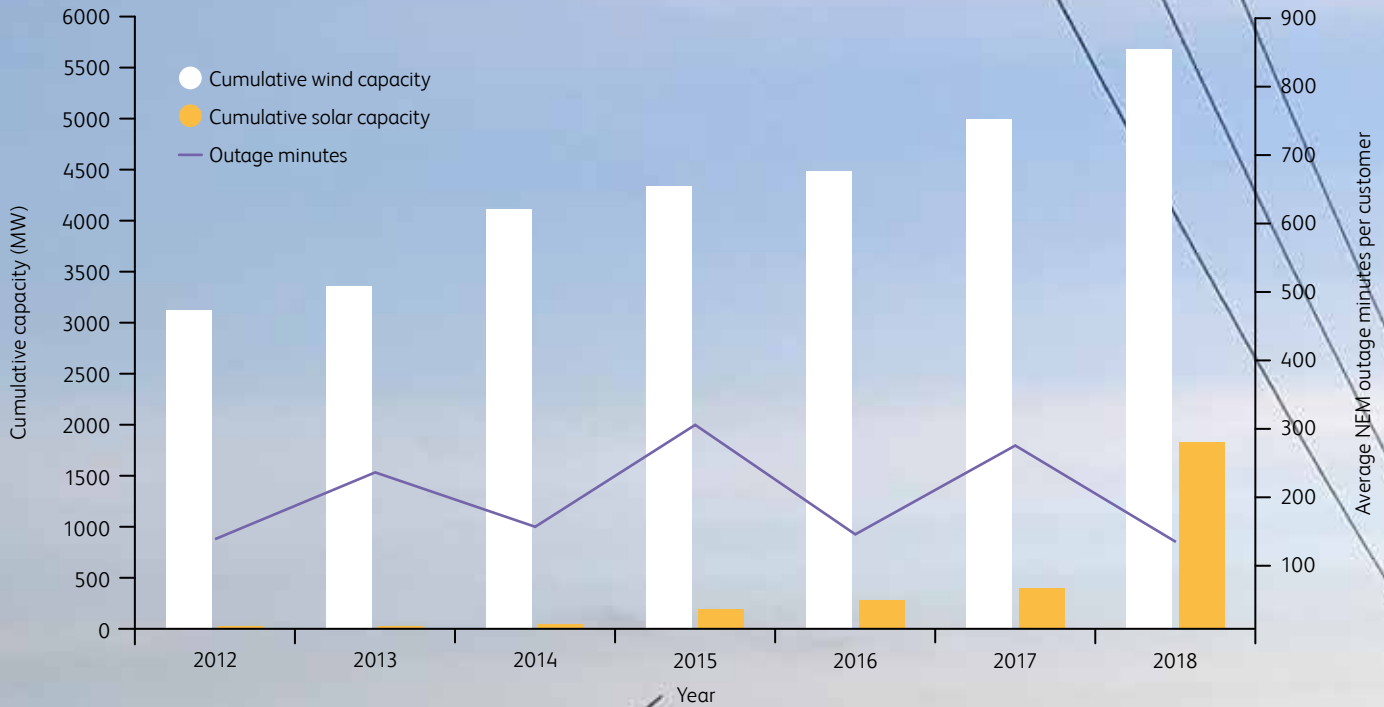
- The NSW Government released its Transmission Infrastructure Strategy in November 2018, which outlines its plan to unlock private sector investment in priority energy infrastructure projects.
- The SA Government committed an initial \$200 million to fund the proposed interconnector between SA and NSW, followed by an additional \$14 million to accelerate early works on construction of the project.
- The Federal Opposition committed \$5 billion to a new Energy Security and Modernisation Fund that would be used to build and upgrade Australia's electricity and gas transmission and distribution systems.
- The Federal Government pledged \$56 million to the proposed second interconnector between Tasmania and the mainland. This has been matched by the Federal Opposition.



Image: High voltage powerlines, Victoria

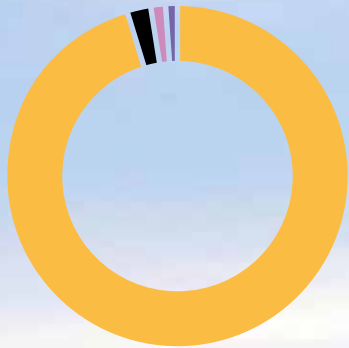
ENERGY RELIABILITY

AVERAGE NATIONAL ELECTRICITY MARKET OUTAGE MINUTES PER CUSTOMER VS WIND AND SOLAR CAPACITY⁵⁰



YEAR	AVERAGE NEM OUTAGE MINUTES PER CUSTOMER	CUMULATIVE WIND CAPACITY (MW)	CUMULATIVE SOLAR CAPACITY (MW)
2012	138	3010	10
2013	235	3234	10
2014	156	3962	30
2015	304	4182	185
2016	145	4325	274
2017	274	4812	382
2018	134	5679	1824

AVERAGE ANNUAL MINUTES OF OUTAGE PER CUSTOMER BY CAUSE, 2009-18⁵⁰



● Distribution ● SA blackout
● Transmission ● Generation shortfall

OUTAGE CAUSE	MINS	%
Distribution	278	97.7
SA blackout	4	1.5
Transmission	2	0.7
Generation shortfall	0	0.1

The national energy system had historically high levels of reliability in 2018, despite the need for occasional load shedding during periods of extreme heat.

A report by the Grattan Institute in early 2019 confirmed what the clean energy industry had known for some time: if anything, the energy system has become more reliable with greater amounts of renewable energy. The report found that 98 per cent of outages over the past decade were caused by problems in transporting and distributing electricity – not the technology which generated it. Only 0.1 per cent of all outages over the same period were due to a lack of generation capacity on hot days.⁵¹ The Grattan Institute argued that misconceptions about the impact of renewables on system reliability can lead to overreactions and knee-jerk policy, which in turn could see electricity bills rise even higher.

Operational challenges remain in introducing larger amounts of energy to the grid and managing system demand. The Australian Energy Market Operator (AEMO) continues to manage demand, partly through commitments

from large energy users who are prepared to shut down or load shed when needed in return for a payment.⁵² AEMO's Integrated System Plan will be used to help with efficient network investment, ensuring that electricity from new renewable energy projects can be used where it is most needed.⁵³ Wider changes to access rules and transmission management, flagged by the Australian Energy Market Commission and Energy Security Board at the end of 2018, will also ensure a more responsive and adaptable energy system.⁵⁴

The rising number of battery storage projects across the system is also enhancing demand management by improving flexibility. The Hornsdale battery in South Australia, for example, responded quickly when the Loy Yang coal-fired power plant tripped and went offline, delivering 100 MW into the national electricity grid in 140 milliseconds.⁵⁵

50 T Wood, G Dundas and L Percival, Grattan Institute, *Keep calm and carry on: managing electricity reliability*, 10 February 2019, <https://grattan.edu.au/report/keep-calm-and-carry-on/>

51 T Wood, G Dundas and L Percival, Grattan Institute, *Keep calm and carry on: managing electricity reliability*, 10 February 2019, <https://grattan.edu.au/report/keep-calm-and-carry-on/>

52 Utility Magazine, *How networks are dealing with today's record temperatures*, 25 January 2019, <https://utilitymagazine.com.au/how-networks-are-dealing-with-todays-record-temperatures/>

53 Australian Energy Market Operator, *Integrated System Plan*, July 2018, https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2018/Integrated-System-Plan-2018_final.pdf

54 Energy Security Board, *Integrated System Plan: Action Plan*, 20 December 2018, <http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/isp%20action%20plan.pdf>

55 News.com.au, *That's a record: South Australia's Tesla battery responds to coal-fired plant failure*, 21 December 2017, <https://www.news.com.au/technology/environment/thats-a-record-south-australias-tesla-battery-responds-to-coalfired-plant-failure/news-story/d9e02c0dbf6774ffea948a1b919f3b7f>



Image: Griffith Solar Farm, New South Wales

An aerial photograph of a vast solar farm. The solar panels are arranged in long, parallel rows that recede into the distance, creating a strong sense of perspective. The panels are dark blue or black with visible white grid lines. The ground between the rows is a mix of dark soil and sparse vegetation. The lighting is soft, suggesting either early morning or late afternoon, with long shadows cast across the panels.

TECHNOLOGY PROFILES



Bioenergy is generated from the conversion of solid and liquid biomass products for use as electricity, heat, gas, liquid fuels and bio-based products.

Bioenergy delivers a range of benefits, including employment and economic development in regional communities, increased energy security, more effective use of waste and a reduction in greenhouse gas emissions. There are 222 operating bioenergy plants in Australia and an additional 55 projects are either under construction or within the feasibility stage of development.⁵⁶

The largest bioenergy project delivered in 2018 was Maryborough Sugar Factory Limited’s Tableland Sugar Mill in Queensland. The \$75 million plant will use sugarcane fibre, known as bagasse, to produce up to 24 MW of electricity – enough to power 28,000 homes in

the Tableland region. Another notable project was the Select Harvest Carina West Cogeneration Plant in Victoria. This 3.1 MW ‘hull-to-energy’ facility is a world-first, using almond hulls and shells as an energy source for generating electricity and steam. Dubbed Project H₂E, the plant will generate enough energy to power the Carina West Processing Facility and irrigation pumps at the Carina Orchard.⁵⁷

In Queensland, the Caboolture landfill now houses a 2.1 MW biogas-fired generator on site, delivering electricity to the grid. The Caboolture generator is one of four being delivered by LGI at landfill sites across Queensland, totalling

6 MW. The project was supported by the Clean Energy Finance Corporation.⁵⁸

Two projects were also delivered in NSW. The 1.6 MW Goulburn Bioenergy Project, supported by ARENA, allows Southern Meats’ existing abattoir facility to break down effluent and produce biogas. The biogas is treated and transferred to two 800 kW dual fuel generators to produce approximately 3800 MWh of electricity per year.⁵⁹

Orora’s 1.5 MW power project at Botany Mill converts waste-water into 12 million kWh of renewable energy per year for the company through the use of an anaerobic digester.⁶⁰ Heat from the engine is also used to preheat water in

LARGEST BIOENERGY PROJECTS

TECHNOLOGY	STATE	OWNER	LOCATION	COMMISSION YEAR	CAPACITY (MW)
Multi-fuel cogeneration	WA	Worsley Alumina Refinery	Collie	2017	114
Bagasse cogeneration	QLD	Sucrogen	Pioneer Mill	2005	68
Black liquor	VIC	Australian Paper	Maryvale	1976 - 1989	54.5
Bagasse cogeneration	QLD	Sucrogen	Invicta	1976 - 1996	50.5
Bagasse cogeneration	QLD	Mackay Sugar	Racecourse	2013	38
Bagasse cogeneration	NSW	Cape Byron Management	Broadwater	2008	38

56 Bioenergy Australia, media release, *Bioenergy - State of the Nation Report has launched*, 4 December 2018, <https://www.bioenergyaustralia.org.au/news/15154/>

57 Select Harvests, *Our Projects*, <http://selectharvests.com.au/our-projects/>

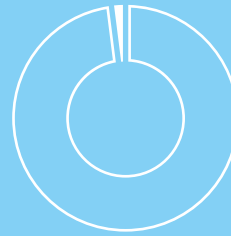
58 Clean Energy Finance Corporation, media release, *CEFC commits \$10 million for Landfill Gas Industries landfill energy expansion*, 10 July 2015, <https://www.cefc.com.au/media/files/cefc-commits-10-million-for-landfill-gas-industries-landfill-energy-expansion/>

59 Australian Renewable Energy Agency, media release, *Goulburn abattoir powering itself using bioenergy*, 12 April 2018, <https://arena.gov.au/news/goulburn-abattoir-powering-using-bioenergy/>

60 P Brescia, Australian Printer, *Orora turning waste into power*, 23 July 2018, <https://www.australianprinter.com.au/News/21310,orora-turning-waste-into-power.aspx>



7.1%
of total clean
energy generated in
Australia in 2018



1.5%
of total Australian
electricity generated
in 2018

the mill, meaning that 90 per cent of the energy used in the process is captured and reused.

In WA, Phoenix Energy and Macquarie Capital will deliver Australia's first waste-to-energy plant. When complete, the Kwinana plant will divert up to half of the residential waste in the Perth metro area from landfill sites. The facility will generate enough electricity to power up to 50,000 households and is supported by a 20-year waste supply agreement with eight local governments.

BIOENERGY PROJECTS COMPLETED IN 2018

PROJECT	STATE	INSTALLED CAPACITY (MW)	FUEL SOURCE
Tableland Sugar Mill	QLD	24.0	Bagasse
Select Harvest Carina West Cogeneration Plant	VIC	3.1	Landfill gas
Caboolture Landfill	QLD	2.1	Food processing waste
Goulburn Bioenergy Project	NSW	1.6	Food processing waste
Orora Botany Mill Power Station 1	NSW	1.5	Waste from paper processing

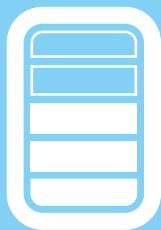
BIOENERGY PRODUCTION BY STATE, 2018 (GWh)



Queensland	1389
New South Wales	1076
Victoria	677
Western Australia	133
South Australia	106
Tasmania	31

Total production
3412 GWh

BATTERY STORAGE



The number of battery storage projects continues to grow across the country as technologies develop and the availability, functionality and cost of many forms of energy storage technology improves.

30%

Australia's expected share of the global household battery market at the end of 2019

\$180M

home battery scheme introduced by the South Australian Government

1 M

Federal Labor's target for the number of households with batteries by 2025

Batteries are supporting the increased uptake of renewable energy while also delivering increased reliability and security to the grid. By the end of 2018, the 100 MW (129 MWh) Hornsdale Power Reserve – famously delivered in less than 100 days in 2017 by Tesla – was still the largest in the world, and a growing number of industrial-sized batteries were completed across Australia. These included the 30 MWh Ballarat Energy Storage System funded by the Victorian Government and ARENA; the 30 MW/8 MWh Dalrymple Energy Storage for Commercial Renewable Integration in South Australia; the 25 MW/50 MWh Gannawarra Energy Storage System, which was retrofitted to an existing solar farm; and the 5 MW Alice Springs Battery Energy Storage System funded through government-owned corporation Territory Generation.

The benefits of utility-scale batteries were clearly demonstrated by the Hornsdale Power Reserve in 2018, which was found to have reduced frequency control ancillary services costs by up to \$50 million. These cost reductions could be even greater if the rules of the National Electricity Market are changed to support fast frequency response.

The role of batteries in reducing network demand and lowering costs for residential consumers was also backed by governments in 2018. The South Australian Government was the first to introduce a \$180 million home battery scheme. The scheme includes a rebate and a low interest loan option, financed by the Clean Energy Finance Corporation, to help households pay for the balance of the battery and new solar panels if required. Those receiving energy bill concessions are eligible for a higher subsidy, ensuring low-income households are supported to access the scheme.

In November 2018, Federal Labor announced that it will fund a Household Battery Program to support 100,000 new battery installations if it is elected in 2019. It has a target of 1 million households with batteries by 2025. The \$200 million program will provide a rebate for eligible battery systems, at a rate of \$500 per kWh of battery capacity, capped at \$2000, for households with a gross annual income less than \$180,000. In addition, Labor will provide \$10 million over four years to boost the Clean Energy Regulator's auditing and inspection regime and an additional

\$10 million Clean Energy Training Fund to support the training of solar and battery installers and energy management system professionals.

All this government support is expected to result in the number of Australian households with batteries tripling to 70,000 in 2019, which means that Australia would account for 30 per cent of the global household battery market by the end of the year.⁶¹

The Battery Safety Guide, developed by the Clean Energy Council with a number of other industry groups, recognises the need to safely manage this growing industry. The guide provides a minimum level of electrical safety criteria for lithium-based battery energy storage equipment. It is supported by the Clean Energy Council's Battery Assurance Program, which provides consumers with a list of energy storage devices that meet industry best practice standards.



Image: Hornsdale Power Reserve, South Australia

HYDRO AND PUMPED HYDRO



Hydro has traditionally been the workhorse of renewable energy generation in Australia, delivering reliable energy since the early 20th century and acting as a perfect complement to growing levels of wind and solar. Hydro had a strong year in 2018, with output over 3600 GWh higher than the previous year.

17,000

GWh of electricity generated by hydro in 2018

50%

increase in generation capacity to be provided by Snowy 2.0

100%

increase in capacity to be provided by the Battery of the Nation Plan

Hydro remained the largest generator of renewable electricity in 2018, providing 35.2 per cent (17,002 GWh). However, wind energy was hot on its heels at 33.5 per cent (16,171 GWh).

Plans to expand and modernise both the Snowy and Tasmanian hydro schemes, plus new investment by government and private investors in pumped hydro, will see hydro's importance continue as costs fall and Australia extends its renewable energy ambitions to meet global emissions reduction obligations.

Snowy 2.0 would increase the generation capacity of the Snowy Hydro Scheme by 50 per cent, with an additional 2000 MW of on-demand

generation and 350,000 MWh of large-scale energy storage. Tasmania's Battery of the Nation initiative could double the state's renewable energy capacity. It will involve repurposing existing hydropower infrastructure, including adding pumped hydro, taking full advantage of Tasmania's unmatched wind resource and developing more interconnection.

Progress towards the development of these significant projects was made in 2018. In March, the Federal Government announced that it would spend \$6 billion to purchase the share of Snowy Hydro owned by Victoria and NSW, giving it greater control of the proposed Snowy 2.0 expansion.

HYDRO POWER'S CONTRIBUTION TO AUSTRALIAN ELECTRICITY GENERATION

YEAR	GENERATION (GWh)	CONTRIBUTION TO RENEWABLES	CONTRIBUTION TO TOTAL ELECTRICITY
2013	19,243	55.4%	8.2%
2014	14,555	45.9%	6.2%
2015	14,046	40.1%	5.9%
2016	17,747	42.3%	7.3%
2017	13,331	34.6%	5.9%
2018	17,002	35.2%	7.5%

62 Snowy Hydro, media release, *Snowy 2.0 approved by the Board*, 12 December 2018, https://www.snowyhydro.com.au/news/news_snowy2approval/

63 Snowy Hydro, media release, *Snowy Hydro welcomes planning approval for Snowy 2.0 exploratory works*, 11 February 2019, <https://www.snowyhydro.com.au/news/snowy-hydro-welcomes-planning-approval-for-snowy-2-0-exploratory-works/>

64 E Laschon, ABC News, *Snowy 2.0 project given funds and approval for early work phase by Federal Government*, 26 February 2019, <https://www.abc.net.au/news/2019-02-26/snowy-2.0-project-approved-for-early-works-stage/10848412>



35.2%
of total clean
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Australia in 2018



7.5%
of total Australian
electricity generated
in 2018

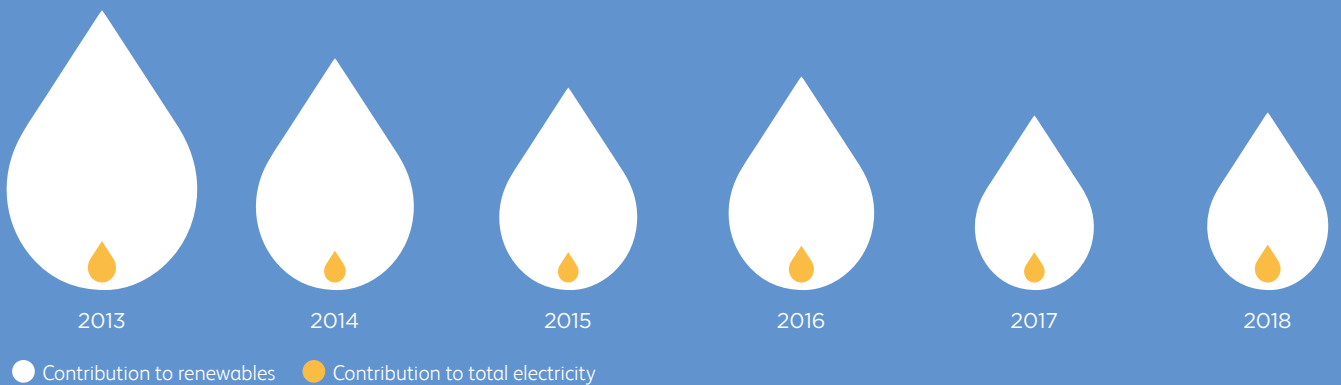
After two years of testing the project’s financial and geotechnical feasibility, the Snowy Hydro board gave the official go-ahead for the 2000 MW expansion to proceed in December.⁶² It also announced the preferred construction, engineering and hydropower companies to help deliver the project and obtained planning approval from the NSW Government for exploratory works.⁶³ The final hurdle for the project was securing the official green light from the company’s major shareholder – the Federal Government. The government announced in February 2019 that it would provide \$1.38 billion to allow Snowy 2.0 to proceed.⁶⁴

Snowy Hydro also signed long-term contracts worth 888 MW with eight NSW and Victorian wind and solar providers that will allow it to provide wholesale prices to its retail customers of less than \$70 a MWh – a price considerably below the cost of electricity from a new coal-fired power plant. Its Renewable Energy Procurement Program saw more than 17,600 MW of projects submitted through the process.⁶⁵

The NSW Government is also committed to extending the role of pumped hydro across the state, releasing a roadmap that identified 24 short-listed pumped hydro projects

across WaterNSW assets that together had capacity of more than 7000 MW.

In Tasmania, the Battery of the Nation project continues to inch closer to reality, with 14 sites examined by Hydro Tasmania for pumped hydro capability.⁶⁶ The pumped hydro developments would run in conjunction with wind power, which would see water pumped uphill at times when demand is low and then released to produce electricity at peak periods.⁶⁷ ARENA has supported the initiative with up to \$5 million funding for feasibility studies, which is being matched by Hydro Tasmania.



65 Snowy Hydro, media release, *Snowy Hydro signs game-changing deals*, 1 November 2018, https://www.snowyhydro.com.au/news/shl_deals/
 66 Hydro Tasmania, media release, *West Coast pumped hydro opportunity*, 4 October 2018, <https://www.hydro.com.au/news/media-releases/2018/10/08/west-coast-pumped-hydro-opportunity>
 67 Hydro Tasmania, media release, *Price is right with hydro*, 11 September 2018, <https://www.hydro.com.au/news/media-releases/2018/09/11/price-is-right-with-hydro>



Rooftop solar backed up a record year in 2017 with an even better one in 2018, as the sector achieved the highest ever number of installations in every state except Tasmania.⁶⁸

5

additional solar systems installed every hour in 2018

There were 218,195⁶⁹ rooftop solar installations in 2018, 43,599 more than the previous year. That's an additional 838 systems every week – or five systems an hour. Around 1.5 GW of capacity was added nationally, taking total national rooftop solar capacity to more than 8.1 GW.

Small-scale solar contributed a fifth (19.6 per cent) of total renewable energy generation, third behind hydro (35.2 per cent) and wind (33.5 per cent). Rooftop solar delivered 4.2 per cent of Australia's total generation in 2018.

By December, 2 million households – one in five – were enjoying the benefits of rooftop solar. Six of the top ten solar postcodes were in Queensland, with the remaining four in Western Australia (three) and Victoria (one).

Commercial systems also gained in popularity, with new locations inspiring innovative system designs. Todae Solar installed a 66 kW system on a 45° pyramid roof, 34 storeys above the Sydney CBD at ISPT's Pitt Street building. Without access to a crane, all the

1.5 GW

of capacity added nationally through rooftop solar

components were measured to fit inside a small elevator and carried manually to the roof. With an average 60 per cent reduction in average daily electricity use,⁷⁰ the effort was worth it.

The industry continued to strengthen its focus on quality and best practice. More than 200 companies have now been accepted into the Clean Energy Council's Approved Solar Retailer program, following strong growth in 2018. Companies must demonstrate their commitment to responsible sales and marketing, offer five-year whole-of-system warranties and use Clean Energy Council accredited installers to qualify for the program, which is designed to make it easier for consumers to choose a reputable company.

With the record amount of solar being installed, the number of accredited solar installers grew to 5864 – up almost 1000 since 2017. The average system size also increased, from 6.39 kW to 7.13 kW, reflecting the falling cost of systems overall and the growing number of small-to-medium businesses installing solar.



**CASE STUDY
HERITAGE AND
INNOVATION COMBINE
TO CREATE WORLD'S
FIRST SOLAR-
POWERED TRAIN**

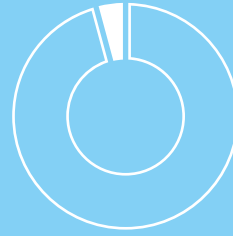
68 Sunwiz Consulting, 2018 - Australian Solar's record-smashing year. In eye-watering charts, 31 January 2019, <http://www.sunwiz.com.au/index.php/2012-06-26-00-47-40/73-newsletter/441-2018-australian-solar-s-record-smashing-year-in-eye-watering-charts.html>

69 The 2018 numbers are based on STC creation up to 31 December 2018 and then adjusted for lags in audit invalidation and then upwards based on historical patterns that 8 per cent of installations create STCs in the subsequent year to installation.

70 Todae Solar, media release, *Todae Solar named finalist in 2018 Design and Installation Awards*, 14 September 2018, <https://www.todaesolar.com.au/resources/news/todae-solar-named-finalist-in-2018-design-and-installation-awards/>



19.6%
of total clean
energy generated in
Australia in 2018



4.2%
of total Australian
electricity generated
in 2018



Image: Byron Bay Solar Train, New South Wales

Seventy years ago, two 600 class rail sets were built at the Chullora Railway Workshops in Sydney, using aluminium aircraft technology developed during the Second World War, to produce a high performance yet lightweight train.

Today, this history of innovation continues, thanks to a group of passionate rail enthusiasts from Byron Bay and Lismore-based solar installation company, Nickel Energy. Together, they replaced the heritage train's traditional diesel engine with electric traction

motors powered by solar to create the world's first solar-powered train.

Curved solar panels were fitted to the roof of both carriages, generating up to 6.5 kW of power to charge the train's lithium-ion battery bank. A 30 kW array on the storage shed roof provides additional back up, while the train's braking system turns the traction motors into generators to recharge.

Since commencing operations in December 2017, the Byron Bay Railway Company has carried more than 90,000

tourists and locals along a 3 km stretch between North Beach Station in Sunrise Beach and the Byron Beach platform in the town's centre.

The service has so far generated 58,210 kWh more energy than it needs, which is exported to the grid via local green energy supplier Enova.

The project earned a Judges' Honourable Mention in last year's Clean Energy Council Solar Design and Installation Awards as a pioneering example of low emissions transport.

TOP SOLAR POSTCODE IN EACH STATE BY NUMBER OF INSTALLATIONS

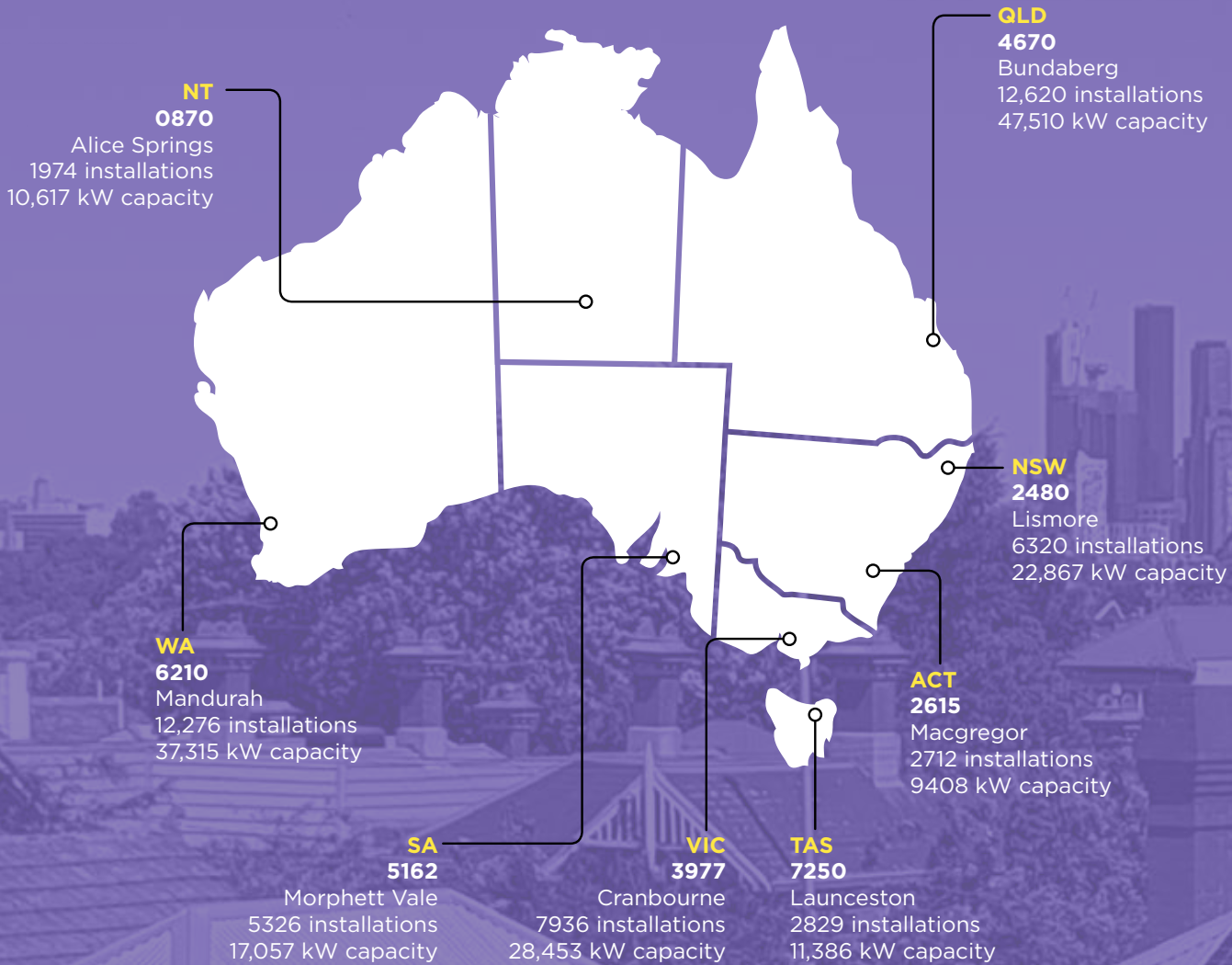
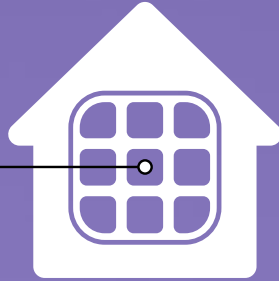


Image: Northcote solar rooftops, Victoria

TOP TEN SOLAR POSTCODES IN AUSTRALIA BY NUMBER OF INSTALLATIONS

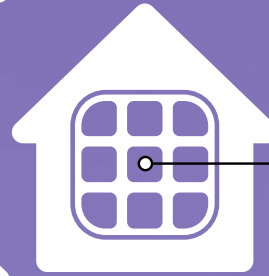
1 BUNDABERG
QLD 4670

12,620 installations
47,510 kW capacity



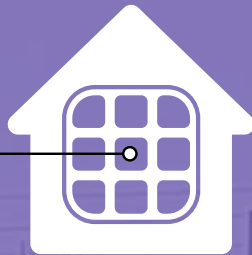
2 MANDURAH
WA 6210

12,276 installations
37,315 kW capacity



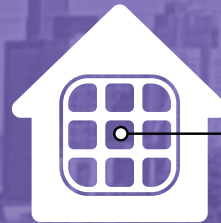
3 HERVEY BAY
QLD 4655

11,387 installations
39,674 kW capacity



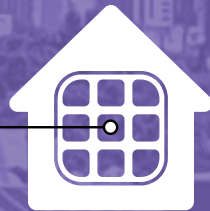
4 CALOUNDRA
QLD 4551

9,956 installations
32,177 kW capacity



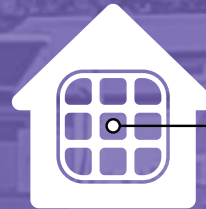
5 TOOWOOMBA
QLD 4350

9,386 installations
36,147 kW capacity



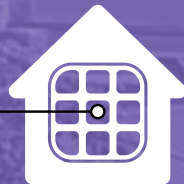
**6 WANGARA AND
WANNEROO**
WA 6065

9,350 installations
37,247 kW capacity



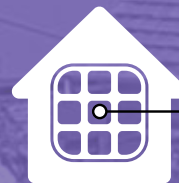
7 NERANG AND CARRARA
QLD 4211

8,208 installations
31,667 kW capacity



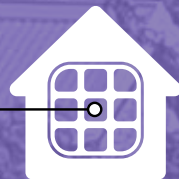
8 MACKAY
QLD 4740

8,091 installations
38,194 kW capacity



9 CRANBOURNE
VIC 3977

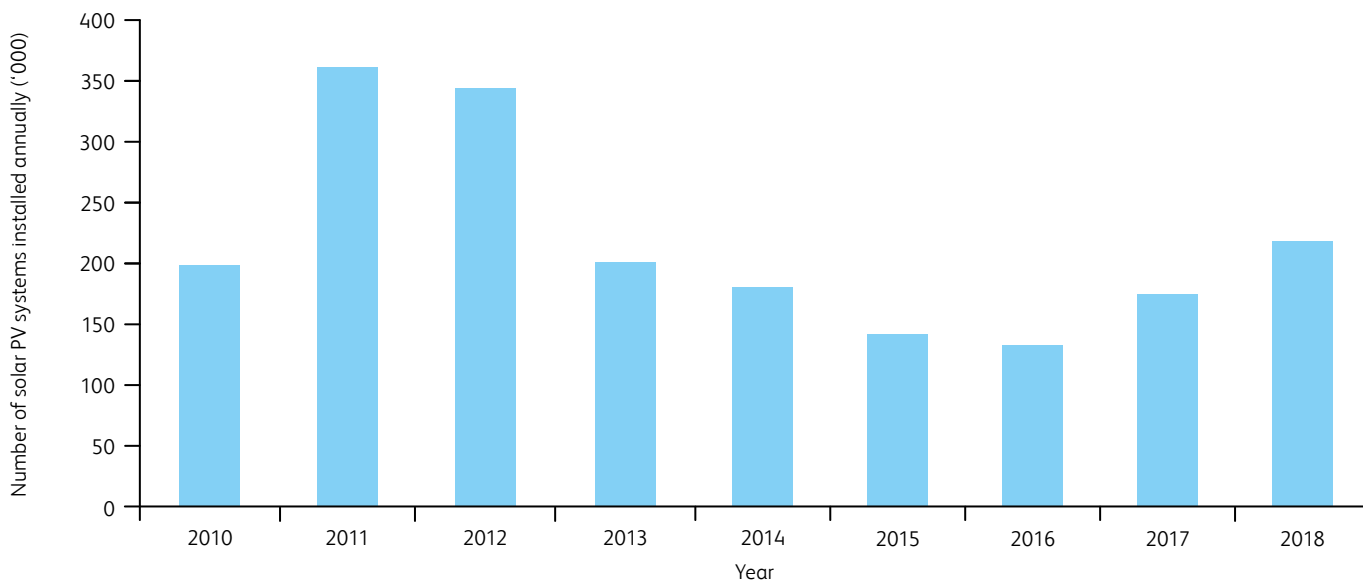
7,936 installations
28,453 kW capacity



10 ARMADALE
WA 6112

7,923 installations
29,943 kW capacity

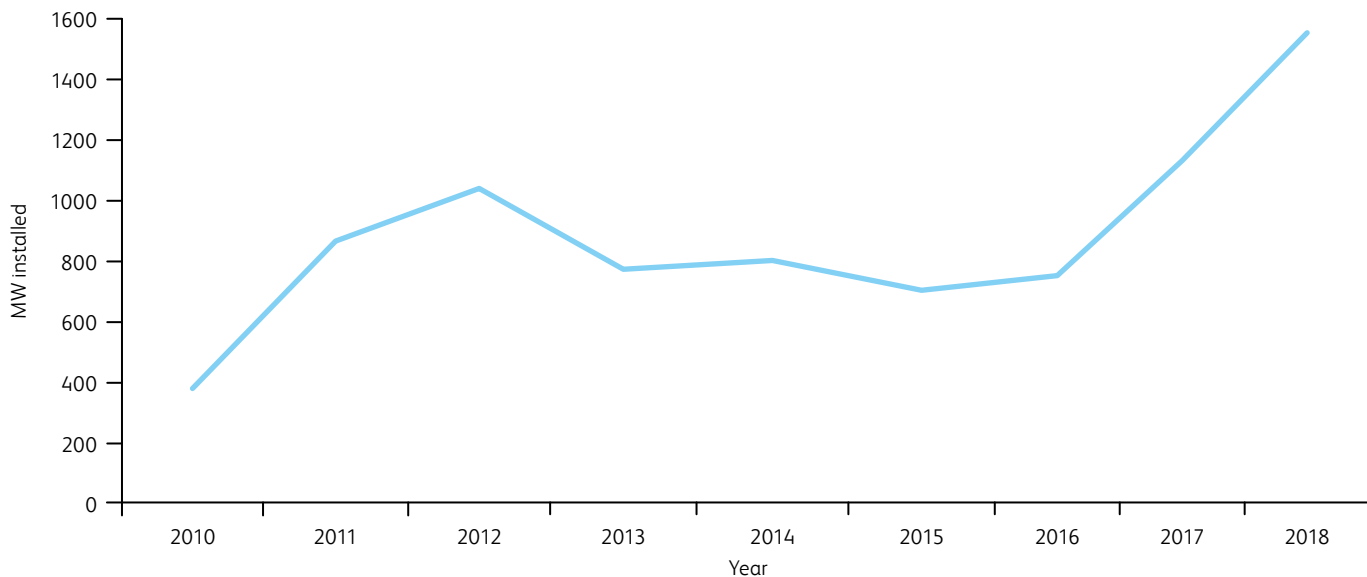


ANNUAL SOLAR PV INSTALLATIONS⁷¹

INSTALLATION YEAR	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	NATIONAL
2010	2323	69,988	637	48,697	16,705	1889	35,676	22,293	198,208
2011	6860	80,272	401	95,303	63,553	2475	60,214	51,667	360,745
2012	1522	53,961	513	130,252	41,851	6364	66,204	42,653	343,320
2013	2411	33,998	1024	71,197	29,187	7658	33,332	21,600	200,407
2014	1225	37,210	1026	57,748	15,166	4207	40,061	23,496	180,139
2015	1066	33,477	1197	39,507	12,081	2020	31,345	20,797	141,490
2016	1001	29,495	1745	34,422	12,604	2487	26,724	24,199	132,677
2017	1944	43,113	1948	46,313	16,172	2389	31,327	31,390	174,596
2018*	3104	58,324	2338	54,201	21,322	2556	43,037	33,315	218,195
TOTAL	22,671	460,116	11,392	602,192	245,714	33,796	381,517	285,607	2,043,003

*2018 numbers are based on STC creation up to 31 December and then adjusted for lags in audit invalidation and then upwards based on historical patterns that 8 per cent of installations create STCs in the subsequent year to installation.

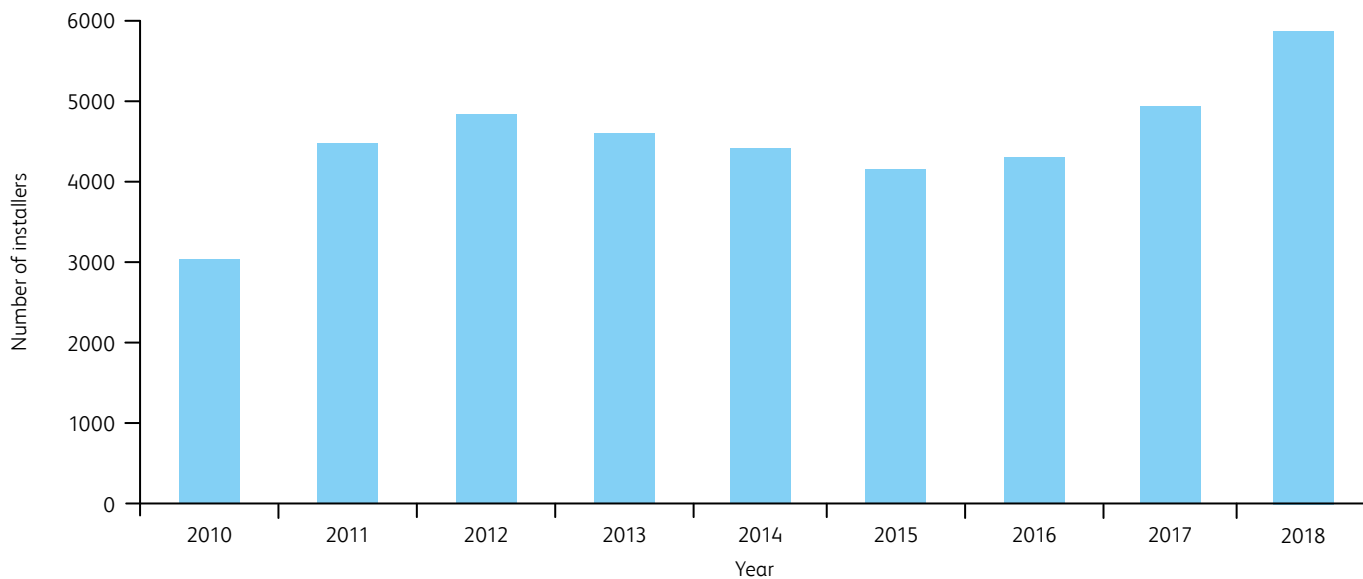
ANNUAL INSTALLED CAPACITY OF SOLAR PV (MW)⁷²



INSTALLATION YEAR	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	NATIONAL
2010	4.66	153.87	1.49	92.37	33.23	3.02	58.96	42.15	389.75
2011	15.86	196.52	1.80	225.19	163.52	5.91	140.41	123.01	872.24
2012	4.64	144.98	2.29	418.41	138.04	20.26	207.58	99.55	1035.75
2013	9.83	134.36	5.05	268.87	141.40	31.50	131.61	69.56	792.19
2014	4.51	172.35	6.12	248.79	82.54	18.96	171.70	95.30	800.26
2015	5.06	177.08	8.64	192.76	66.64	9.53	149.98	96.24	705.92
2016	6.21	167.35	12.70	199.53	77.67	11.84	144.46	128.05	747.82
2017	11.00	262.85	15.26	306.06	115.22	14.53	205.20	186.24	1116.37
2018**	21.40	410.47	19.69	401.04	168.90	18.03	305.41	210.82	1555.75
TOTAL	84.89	1845.72	74.63	2383.80	1008.44	135.61	1530.53	1069.21	8132.83

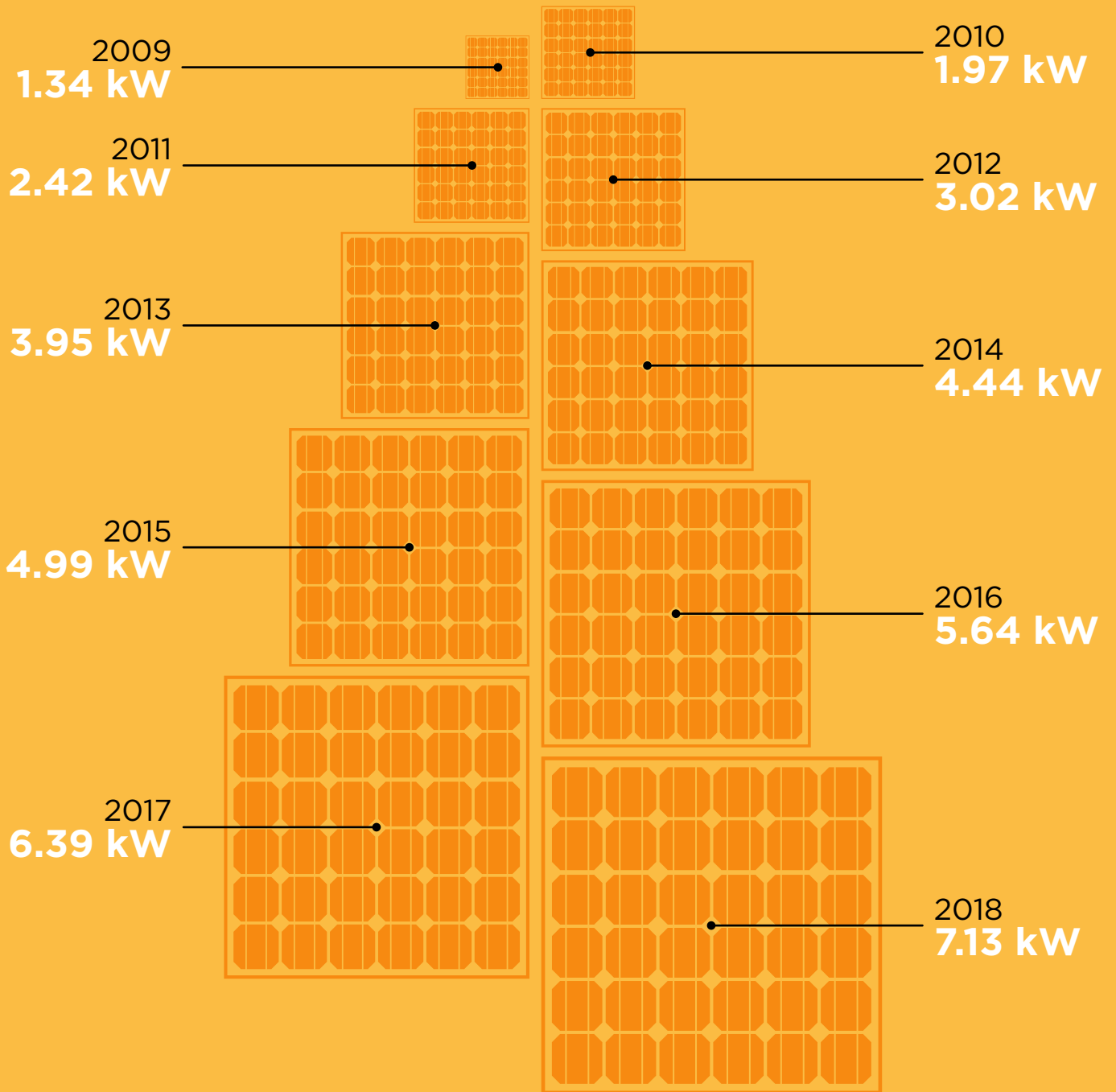
** 2018 numbers are based on STC creation up to 31 December and then adjusted for lags in audit invalidation and then upwards based on historical patterns that 8 per cent of capacity create STCs in the subsequent year to installation.

TOTAL NUMBER OF ACCREDITED INSTALLERS AND DESIGNERS



YEAR	NSW	ACT	WA	QLD	VIC	NT	SA	TAS	Intl	TOTAL
2010	879	46	414	675	754	16	252	45	3	3084
2011	1034	53	531	1187	1004	22	593	71	2	4497
2012	948	48	514	1391	1122	28	650	120	3	4824
2013	894	44	439	1336	1093	41	604	144	6	4601
2014	908	44	401	1263	1075	47	521	137	8	4404
2015	916	44	384	1151	998	51	490	109	7	4150
2016	951	56	465	1188	974	70	500	101	7	4312
2017	1085	66	612	1354	1059	72	552	112	7	4919
2018	1323	91	712	1571	1316	81	653	112	5	5864

NATIONAL AVERAGE SYSTEM SIZE (KW)⁷³



73 Clean Energy Regulator, Green Energy Markets

SOLAR

MEDIUM SCALE: SYSTEMS BETWEEN 100 KW AND 5 MW

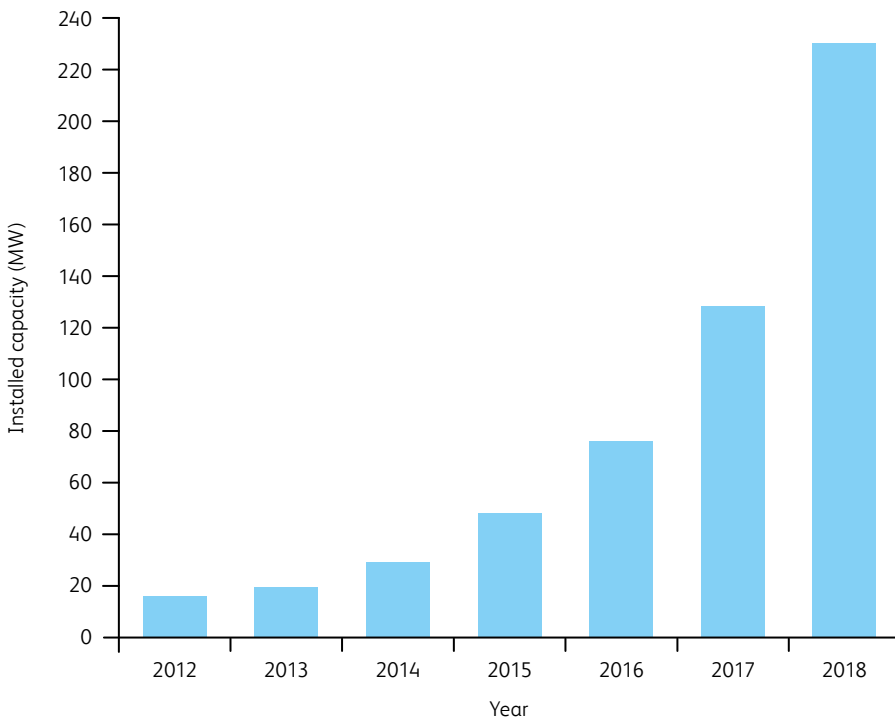


Medium-scale solar systems grew by 80 per cent in 2018 as shopping centres, hospitals, schools, commercial buildings and others took back control of their rising electricity costs and ramped up their focus on sustainability. Cumulative installed capacity of solar in this category went from approximately 128 MW in 2017 to 230 MW in 2018.

Some of the notable medium-scale systems installed or commencing installation in 2018 include a 2.2 MW system at the Sydney Markets, a 500 kW system at the Willinga Park Equestrian Centre in NSW, a 159 kW installation at AccorHotels' Novotel Barossa Valley, a 2.8 MW system across two sites of Jacob's Creek winery and more than 11 MW of commercial solar across five of Vicinity Centres' shopping complexes in Western Australia and South Australia.

Creative design solutions are also emerging in this category. For example, Australia's first modular and scalable floating solar PV system was installed by Suntrix on an overflow dam at the East Lismore Sewage Treatment Plant in 2018. The 99 kW system will meet about 11 per cent of the site's annual electricity needs and there are plans to expand it to 400 kW.

CUMULATIVE INSTALLED CAPACITY (MW)⁷⁴



CASE STUDY

SOLAR SOLUTION REDUCES REMOTE COMMUNITY'S RELIANCE ON DIESEL

From a city dweller's perspective, it doesn't get much more remote than the indigenous community of Lockhart River in Far North Queensland – a lazy 17-hour drive north of Cairns.

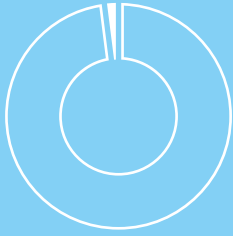
Like many other remote communities across Australia, Lockhart River relies on a small isolated power station fuelled by diesel for its electricity.

In an attempt to reduce diesel consumption and operational costs, Energy Queensland partnered with the Queensland Government to install 200 kW of solar PV on government and community buildings in the town.

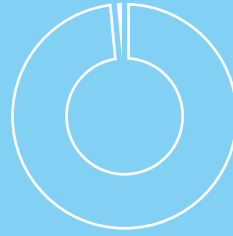
Solar now makes up 10 per cent of the community's power supply and has reduced diesel use by 75,000 litres per year. These cost savings are redirected to benefit community residents, with eligible households receiving \$100 every year for the next 20 years.

The Lockhart River Solar Project won the Innovation Award at the 2018 Clean Energy Council Awards in August.

⁷⁴ Clean Energy Regulator, Green Energy Markets



0.8%
of total clean
energy generated in
Australia in 2018



0.2%
of total Australian
electricity generated
in 2018



Image: Sydney Markets, New South Wales

CASE STUDY

AWARD-WINNING SOLAR POWERS AUSTRALIA’S BIGGEST WHOLESALE MARKET

As the nation’s largest wholesale fruit, vegetable and flower market, Sydney Markets is used to operating on a grand scale.

And now the 43-hectare site in Flemington also houses Australia’s largest private sector rooftop solar set up, with an expansive 8594 solar panels capable of generating more than 3 MW of electricity. The \$8.9 million investment means that solar now provides 11 per cent of Sydney Markets’ annual power consumption.

The installation earned installers Jarrod Shepherd and Matthew Linney from Autonomous Energy a 2018 Clean Energy Council Solar Design and Installation Award in the over 240 kW category. In addition to the massive scale of the installation, it included innovative solutions such as the use of reflective paint to reduce heat loads on the building, which is particularly important in areas that mostly contain cool rooms.

The Chair of Sydney Markets, John Pearson, said that the site has capacity to more than triple the generation of the system in the future to further meet its energy needs.

Medium-scale systems (between 100 kW and 5 MW) are on the rise in Australia, with more than 100 MW installed in 2018.

With a strong history in sustainability, particularly in the area of waste management, Sydney Markets is getting closer to its goal of being Australia’s greenest food market.



Large-scale solar officially announced its arrival as a genuine renewable energy contender in 2018, with 28 projects adding 1442 MW of new capacity. Queensland led the way with 14 new solar farms commissioned in 2018.

59

large-scale solar projects under construction or financially committed at the end of 2018

68%

of all renewable energy projects under construction or financially committed at the end of 2018 were large-scale solar

52,000

average homes can be powered by the 150 MW Coleambally Solar Farm in NSW

Large-scale solar had a breakout year in 2018, with the amount of new capacity installed more than 14 times higher than the sector's previous best year. The Renewable Energy Target, the decreasing cost of technology, corporate power purchase agreements (PPAs) and some assistance from ARENA were the main drivers of this success.

The three largest solar farms commissioned in 2018 were Neoen's Coleambally Solar Farm (150 MW) in south-west NSW, the Darling Downs Solar Farm (138 MW) and the Clare Solar Farm in Port Augusta (128 MW).

The Coleambally project will generate approximately 380,000 MWh of electricity into the national power grid each year, which is enough to power approximately 52,000 average homes. Tracking technology ensures that Coleambally's production peak lasts from around 8.30am until after 4pm, maximising its output. It's supported by a 12-year PPA with energy retailer EnergyAustralia, which will take about 70 per cent of the solar farm's energy output. The remainder, including large-scale certificates, will be sold directly to the market.⁷⁵

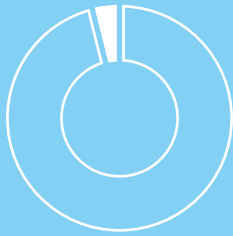
The sector is experiencing some challenges as the market adjusts to the speed and scale of its expansion. Leading engineering firm RCR Tomlinson was placed into voluntary administration in November, after the structure of several key contracts left it financially exposed to delays in connecting to the power grid.⁷⁶ Grid connection issues – including delays, rule changes and network capacity – remain a key issue, as industry and regulators navigate new territory to meet investment demand.

As of 31 December 2018, there were 59 large-scale solar projects under construction or financially committed across Australia, 34 per cent of them in Queensland. Those under construction range in size from the 5 MW Moyall Solar Farm in South Australia to the 349 MW Limondale Solar Farm in Balranald, NSW. Of the 87 large-scale renewable energy projects under construction or financially committed at the end of 2018, over two thirds were large-scale solar.

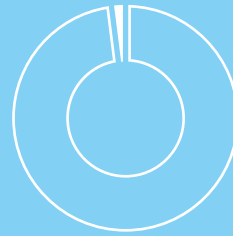
⁷⁵ G Parkinson, RenewEconomy, *Australia's biggest solar farm at Coleambally sets new production records*, 23 November 2018, <https://reneweconomy.com.au/australias-biggest-solar-farm-at-coleambally-sets-new-production-records-67215/>

⁷⁶ S Vorrath, RenewEconomy, *RCR administrator blames solar for company's collapse*, 29 November 2018, <https://reneweconomy.com.au/rcr-administrator-blames-solar-for-companys-collapse-78708/>

⁷⁷ Green Energy Markets, Clean Energy Council database



3.9%
of total clean
energy generated in
Australia in 2018



0.8%
of total Australian
electricity generated
in 2018

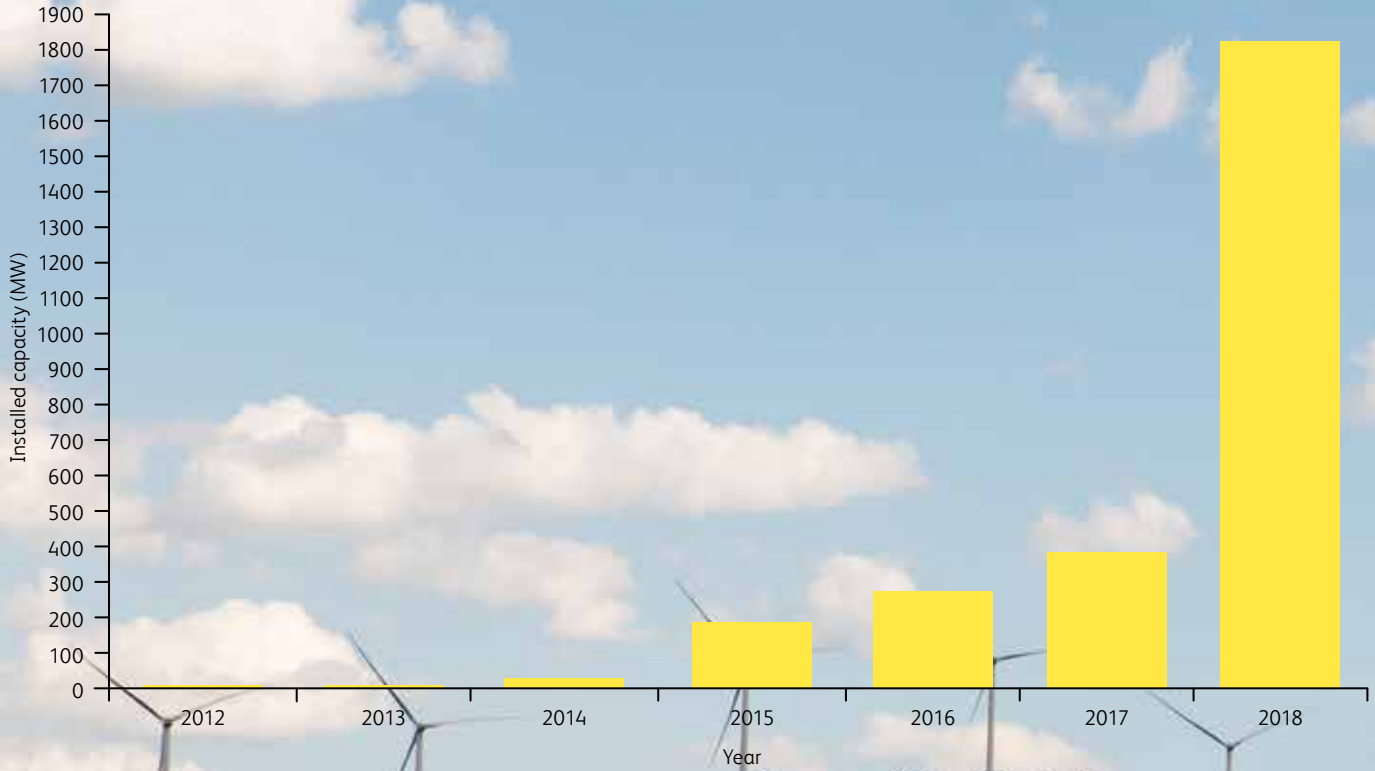
LARGE-SCALE SOLAR PLANTS COMMISSIONED IN 2018⁷⁷

PROJECT	OWNER	STATE	INSTALLED CAPACITY (MW)	INVESTMENT (A\$M)	JOBS
Coleambally Solar Farm	Neoen	NSW	150	200	400
Darling Downs Solar Farm	APA Group	QLD	138	217	200
Clare Solar Farm	FRV	QLD	128	190	200
Sun Metals Solar Farm	Sun Metals	QLD	124	199	250
Bannerton Solar Farm	Foresight Solar	VIC	110	98	N/A
Wemen Solar Farm	Wirsol Energy	VIC	110	110	600
Emerald Solar Park	Lighthouse Solar	QLD	90	110	200
Hamilton Solar Farm	Edify Energy	QLD	69	138	325
Whitsunday Solar Farm	Edify Energy	QLD	69	122.4	200
Parkes Solar Farm	Neoen	NSW	66	114	80
Gannawarra Solar Farm - Stage 1	Wirsol Energy and Edify Energy	VIC	60	100	50
Manildra Solar Farm	First Solar	NSW	56	109.3	N/A
Kidston Solar Project - Stage 1	Genex	QLD	50	126	100
Griffith Solar Farm	Neoen	NSW	36	230	250
Dubbo Solar Hub	Neoen	NSW	29	55.6	165
Emu Downs Solar Farm	APA Group	WA	20	47.2	100
Hughenden Solar Farm	Overland Sun Farming	QLD	20	34.08	100
Swan Hill Solar Farm	Impact Investment Group/ Australian Solar Group	VIC	19	36	59
Longreach Solar Farm	Canadian Solar	QLD	17	31	30
Kennedy Energy Park - Solar	Windlab and Erusus Energy	QLD	15	36	30
Lakeland Solar and Storage Project	Conergy	QLD	13	42.5	60
Dunblane Solar Farm	Ydot Projects	QLD	11	N/A	N/A
Gullen Range Solar Farm	New Gullen Range Wind Farm	NSW	10	26	70
Northam Solar Farm	Carnegie/Lend Lease	WA	10	20	30
Brisbane Airport	Epho	QLD	6	N/A	N/A
Whyalla Solar Farm - Stage 1	SSE Australia	SA	6	N/A	20
Normanton Solar Farm	Canadian Solar and Scouller Energy	QLD	5	14	20
Peterborough Solar Farm	Renew Power Group	SA	5	9.5	40

SOLAR

LARGE SCALE: SYSTEMS LARGER THAN 5 MW (CONTINUED)

CUMULATIVE INSTALLED CAPACITY (MW)⁷⁸



YEAR	2012	2013	2014	2015	2016	2017	2018
CUMULATIVE INSTALLED CAPACITY (MW)	10	10	30	185	275	382	1824

⁷⁸ Green Energy Markets, Clean Energy Council database

TOP FIVE PLANTS BY SIZE⁷⁹

COLEAMBALLY, NSW

Owner: Neoen
Commissioned: 2018

150 MW

DARLING DOWNS, QLD

Owner: APA Group
Commissioned: 2018

138 MW

CLARE, QLD

Owner: FRV
Commissioned: 2018

128 MW

SUN METALS TOWNSVILLE, QLD

Owner: Sun Metals
Commissioned: 2018

124 MW

BANNERTON, VIC

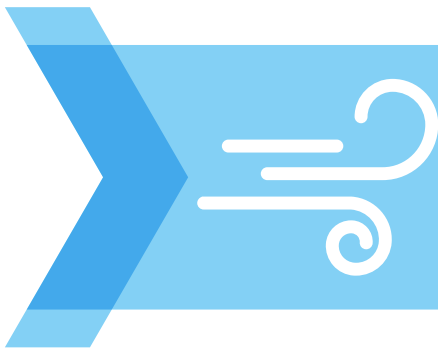
Owner: Foresight Solar
Commissioned: 2018

110 MW

Image: White Rock Wind and Solar Farm, New South Wales

TECHNOLOGY PROFILES

WIND POWER



Batteries and large-scale solar may have stolen some of the media spotlight in 2018, but wind remains the cheapest form of new energy to build and a significant contributor to the nation's electricity generation.

Over 850 MW of wind energy was installed in 2018, making it the best ever year for installed wind farm capacity.

AGL's Macarthur Wind Farm in south-western Victoria remains the nation's largest at 420 MW – although Goldwind's 530 MW Stockyard Hill Wind Farm, which is currently under construction, will claim the title once it is completed in 2020. At 270 MW, the Sapphire Wind Farm is the largest wind farm in NSW, followed by Goldwind's 175 MW White Rock Wind Farm in the New England Tablelands.

Of the nine new wind farms commissioned in 2018, five were in Victoria. In early 2019, the Victorian Government approved an 800–1000 MW wind power project proposed for Victoria's Golden Plains Shire by German company WestWind Energy.

At the end of 2018, 24 wind farms with a combined capacity of 5.69 GW were under construction or financially committed nationally, representing more than \$8 billion of investment and creating almost 5000 jobs. Victoria led the way, with half of all new wind farms under construction or financially committed.





33.5%
of total clean
energy generated in
Australia in 2018



7.1%
of total Australian
electricity generated
in 2018

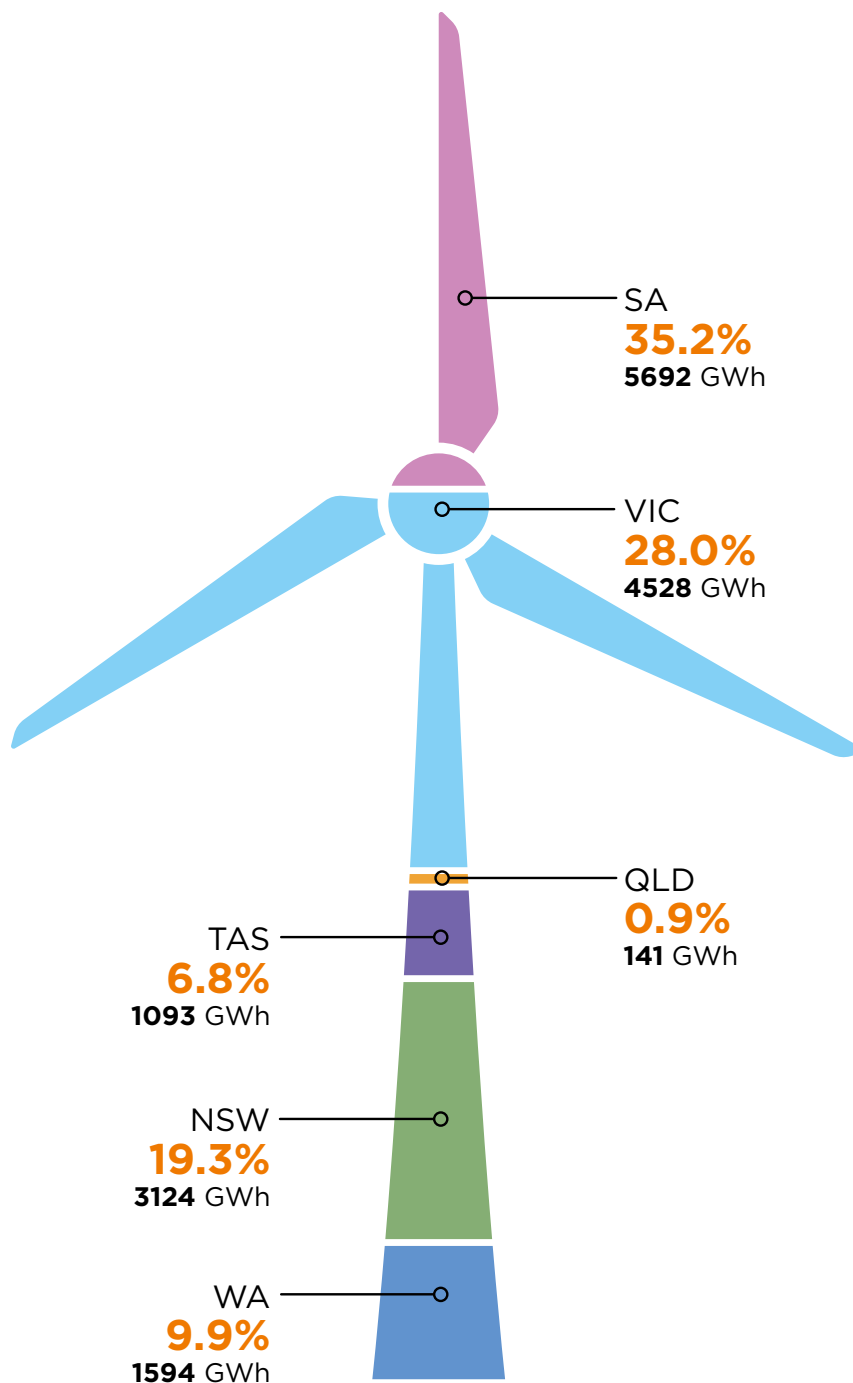
WIND FARMS COMMISSIONED IN 2018

PROJECT	OWNER	STATE	CAPACITY (MW)
Sapphire Wind Farm	Partners Group and CWP Renewables	NSW	270
Mt Emerald Wind Farm	RATCH	QLD	181
Mt Gellibrand - Stage 1	ACCIONA	VIC	138
Bodangora Wind Farm	Infigen Energy	NSW	113
Salt Creek Wind Farm	Tilt Renewables	VIC	54
Kennedy Energy Park - Wind	Windlab and Erusus Energy	QLD	43.5
Kiata Wind Farm	Windlab	VIC	31
Yaloak South Wind Farm	Pacific Hydro	VIC	29
Maroona Wind Farm	BayWa r.e.	VIC	7



Image: Hornsdale Wind Farm, South Australia

PERCENTAGE OF WIND GENERATION BY STATE⁸⁰



TOP FIVE PLANTS BY SIZE

MACARTHUR, VIC

Owner: HRL Morrison and
Malakoff Corporation
Commissioned: 2012

420 MW

SNOWTOWN 2, SA

Owner: Tilt Renewables
Commissioned: 2014

270 MW

SAPPHIRE, NSW

Owner: Partners Group and
CWP Renewables
Commissioned: 2018

270 MW

ARARAT, VIC

Owner: RES
Commissioned: 2017

240 MW

COLLGAR, WA

Owner: UBS IIF/REST
Commissioned: 2012

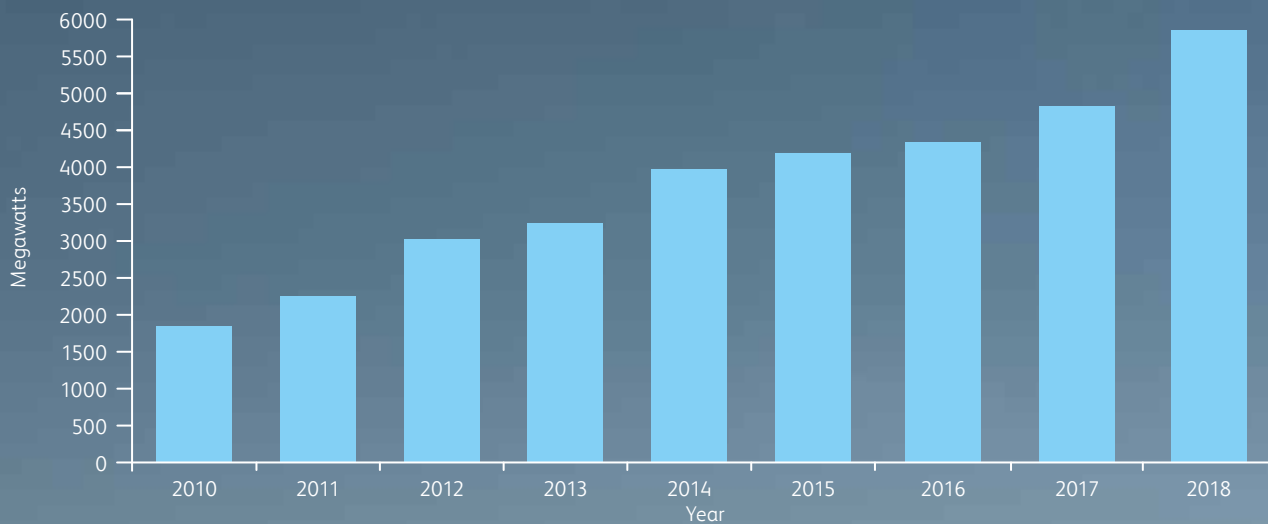
206 MW



Image: Stockyard Hill Wind Farm, Victoria

TECHNOLOGY PROFILES
WIND POWER (CONTINUED)

CUMULATIVE INSTALLED WIND CAPACITY IN AUSTRALIA⁸¹



YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018
CUMULATIVE INSTALLED CAPACITY (MW)	1840.1	2241.5	3009.8	3234.4	3962.1	4181.7	4324.7	4812.2	5678.7

ANNUAL INSTALLED WIND CAPACITY IN AUSTRALIA⁸¹



YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018
CUMULATIVE INSTALLED CAPACITY (MW)	158.7	401.3	768.3	224.6	727.8	219.6	143.0	487.6	866.5

⁸¹ Green Energy Markets, Clean Energy Council database



Image: Hornsdale Wind Farm , South Australia

CASE STUDY BATTERY-BACKED WIND FARM DELIVERS RELIABLE ENERGY TO GREENHOUSE FARMING OPERATION

Reliable and affordable energy is essential for Australian businesses to remain globally competitive, and the Bulgana Green Power Hub proves that battery-backed wind energy is an attractive solution.

The power hub, which is currently under construction on 7500 hectares of private freehold sheep grazing country near Stawell in Victoria, will provide more than 750,000 MWh of renewable energy every year.

National agri-business Nectar Farms, which adjoins the Bulgana Green Power Hub, has signed a 10-year power purchase agreement to purchase 15 per cent of Bulgana's capacity, with the remainder being fed into the national grid. Nectar Farms will use the emissions-free energy from Bulgana to expand its hydroponic fruit and vegetables operation, creating more than 1300 jobs in rural Victoria.

Developed and operated by French renewable energy company Neoen, with a 15-year support agreement from the Victorian Government, the hub will combine 194 MW of wind with a 20 MW lithium-ion Tesla battery.

Its emissions reductions are equivalent to taking 230,000 cars off the road or planting 1.2 million trees, helping the state to deliver on its target of 20 per cent emissions reduction by 2020.

The wind farm is due to be completed by the end of 2019.

HYDROGEN

There was considerable interest in renewable hydrogen in 2018, activating significant policy and investment activity.

In August, CSIRO produced a blueprint for the development of a hydrogen industry in Australia. In September, ARENA committed \$22.1 million in funding for 16 research projects to accelerate its development.

One of the projects included \$7.5 million for Jemena to build a 500 kW electrolyser at its facility in western Sydney, which will convert solar and wind power into renewable hydrogen.

The two-year trial – the largest of its kind in Australia – will inject small amounts of renewable hydrogen into the Sydney gas network to demonstrate the potential for renewable hydrogen storage. A portion of the hydrogen will be used for electricity generation, with the remaining stored for use in an onsite refuelling station for hydrogen fuel cell vehicles.⁸²

At the end of 2018, Evoenergy and the Canberra Institute of Technology

opened Australia's first hydrogen test facility to test 100 per cent hydrogen on existing materials, equipment and work practices in preparation for application to the existing gas distribution network. Plumbing students will be trained as part of the research.

In December, the COAG Energy Council agreed to establish a dedicated Working Group to support the development of a competitive hydrogen industry and make Australia a major global player in the market by 2030. The Working Group will be chaired by Australia's Chief Scientist, Dr Alan Finkel.

Federal Labor also announced a big commitment to the burgeoning industry in early 2019, earmarking more than \$1 billion for research, demonstration and pre-commercial deployment of hydrogen technologies should it win the 2019 Federal Election. It has earmarked Gladstone in Queensland as the hydrogen capital of Australia, and will establish the National Hydrogen Innovation Hub in the Queensland regional city.⁸³

GEOTHERMAL

Commercial-scale geothermal technology in the Australian residential sector took a step forward, with Alinta Energy announcing plans to commercialise geothermal heating and cooling – and potentially even hot water – following a successful rollout in a major housing development in the Sydney suburb of Blacktown.⁸⁴

MARINE

It was a challenging year for marine energy in Australia, after Carnegie Energy – a flagship company set to develop Australia's first commercial wind and tidal energy project in Albany, Western Australia – experienced project setbacks and significant financial losses. The company took on a number of solar-battery hybrid energy projects which it blames for the setbacks. Despite this, wave energy remains one of the largest untapped renewable resources in Australia.⁸⁵

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Image: Hydrogen fuel cell

CASE STUDY

CLEAN HYDROGEN COULD POWER AUSTRALIA'S NEXT EXPORT BOOM

Hydrogen is the simplest element, the most plentiful in the universe. But this common gas is no lightweight. In fact, both ARENA and CSIRO believe that hydrogen could be the missing element that allows us to develop an export industry for renewable energy to one day rival liquefied natural gas.

The potential of hydrogen is enormous: it can heat buildings, power vehicles and supply industrial heat – all with little to no emissions.

In September 2018, ARENA provided \$22.1 million in funding for 16 research projects to accelerate the development of renewable hydrogen so that Australia is well positioned

to seize the opportunities of this emerging industry.

It follows on from ground-breaking research by CSIRO in August 2018 which separated ultra-high purity hydrogen from ammonia, blocking all other gases. The membrane technology developed by CSIRO paves the way for bulk hydrogen to be transported as ammonia using existing infrastructure and then reconverted into hydrogen at the point of use.

If this opportunity is managed properly, low-emissions hydrogen produced in Australia could supply fuel cell vehicles around the world. ARENA says that with the right

conditions, hydrogen exports could be worth \$1.7 billion annually and generate 2800 jobs in Australia by 2030.

Renewable hydrogen's export potential is also fuelling plans for the massive Asia Renewable Energy Hub in north-west WA. The giant hybrid wind and solar project aims to provide cheap energy to the Pilbara's local manufacturing base and export renewable energy to south-east Asia via a sub-sea cable. The hub's 7.5 GW of wind turbines and 3.5 GW of solar PV arrays could generate more than 40 terawatt hours of energy per annum, which equates to nearly 20 per cent of Australia's total electricity generation.



Image: Dubbo Solar Farm, New South Wales



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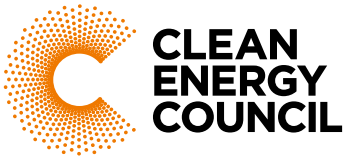
The Clean Energy Council thanks the following members and industry stakeholders for providing some of the photographs in this report:

- ACCIONA
- Autonomous Energy
- Bright Brewery
- Epuron
- Genex Power
- Goldwind
- Hydro Tasmania
- Infigen Energy
- Neoen
- Nickel Energy
- Pacific Hydro
- RES



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