

# **CLEAN ENERGY AUSTRALIA**

## **REPORT 2018**



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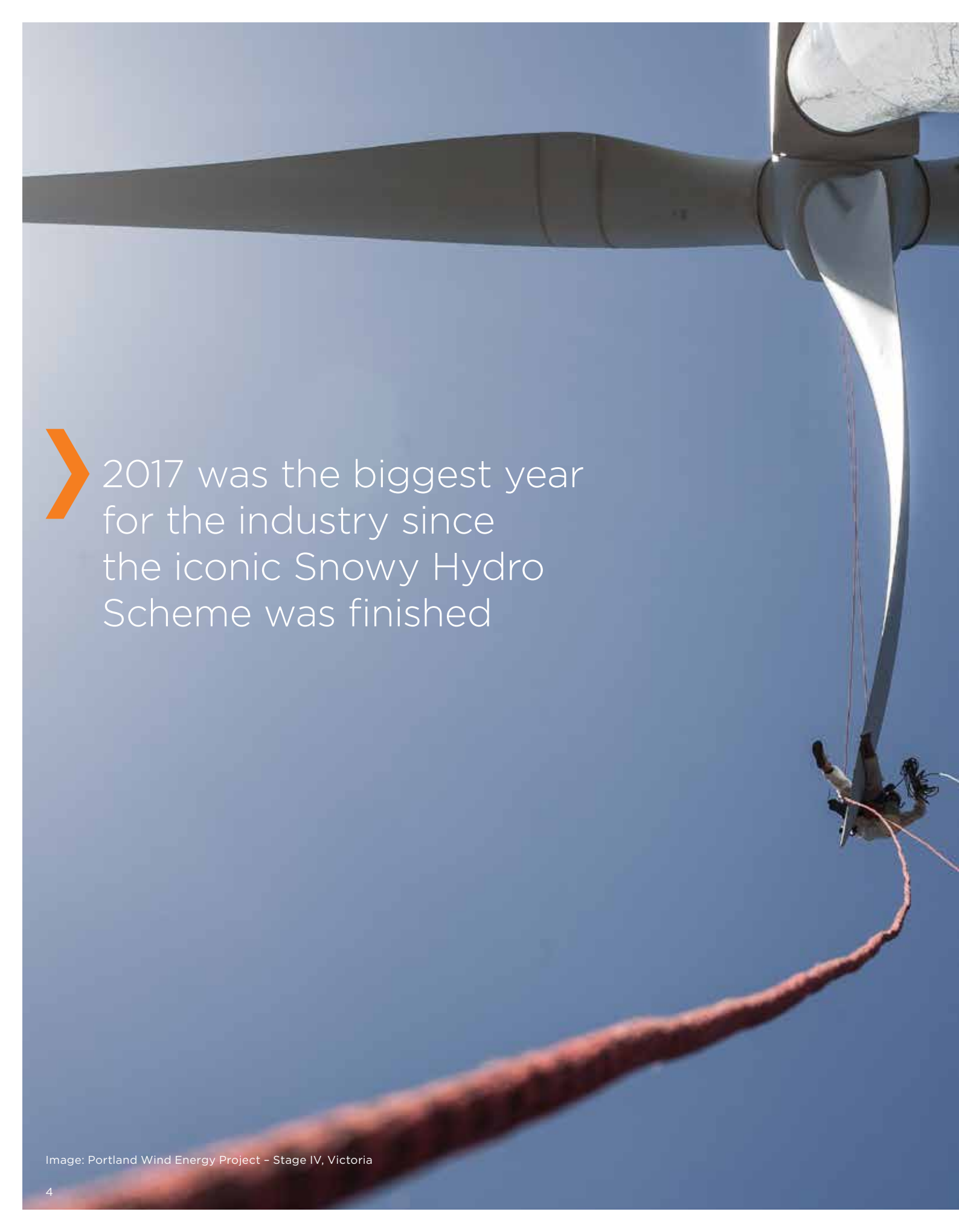
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➤ 2017 was the biggest year for the industry since the iconic Snowy Hydro Scheme was finished

# INTRODUCTION



**Kane Thornton**  
Chief Executive,  
Clean Energy Council

After a decade of stops and starts, 2017 was the biggest year for the industry since the iconic Snowy Hydro Scheme was finished more than half a century ago. And it was a record-breaking year on many fronts.

Not only did we see records falling for both rooftop solar and large-scale renewables, but the Clean Energy Regulator also announced that there are enough projects now committed to meet the 2020 Renewable Energy Target (RET).

More than 1100 MW of rooftop solar power capacity was installed during the year, eclipsing the previous best in 2012.

At the turn of the year, more than 50 large-scale wind and solar projects were under construction or scheduled to start in the near future, representing more than 5300 MW of new generating capacity, \$10 billion in investment and 5750 new direct jobs.

Heading into 2018, renewable energy represented the lowest-cost type of new energy generation that can be built. This not only makes wind and solar an

extremely attractive investment, but it also means the unprecedented program of works is expected to reduce household power bills by hundreds of dollars every year.

We believe the next few years will be extremely busy as the industry builds out the RET. This is great news for Australian small and medium businesses able to pivot into supplying goods and services to this booming sector.

The world's biggest battery – built after a Twitter conversation between Tesla's Elon Musk and Australian tech billionaire Mike Cannon-Brookes – is now up and running in South Australia at Neoen's Hornsdale Wind Farm. It has already proven its worth, responding quickly when the coal-fired Loy Yang power plant tripped and went offline, effortlessly outpacing traditional generators to help stabilise the electricity system.

This was not the only time Australia's ageing coal-fired power stations struggled during the recent summer. Temperature rises, demand spikes and weather events have led to some of the

largest coal plants in the country simply dropping out when times get tough. They are not getting any younger.

In other promising news, the Prime Minister appears committed to the expansion of the iconic Snowy Hydro Scheme. Snowy 2.0 could increase the scheme's generation capacity by up to 2000 MW and, at full capacity, will provide approximately 350,000 MWh of energy storage. It is also a good complement to wind and solar, delivering stable and affordable electricity that can be dispatched on demand. Meanwhile, a number of companies are exploring other new pumped hydro projects.

As the momentum builds in 2018, I can't help but feel energised and optimistic about the renewable energy sector and the gift we are giving future generations of Australians.

A handwritten signature in white ink, appearing to read 'Kane Thornton', located at the bottom right of the page.

# EXECUTIVE SUMMARY

2017 was an important turning point for the industry

Image: Snowtown 2 Wind Farm, South Australia

Approximately 700 MW of renewable projects were completed and began generation in 2017. But with seven times that amount either under construction or with financial support at the end of 2017, the clean energy industry is on the verge of a major breakthrough.

Large-scale wind and solar project activity pushed investment in Australia up 150 per cent to a record US\$9 billion in 2017, and early in 2018, the Clean Energy Regulator announced that there were enough projects at a sufficiently advanced stage to meet the large-scale Renewable Energy Target. This is a remarkable achievement considering that just over half of the target had been met at the beginning of 2017.

Almost 1.1 GW of solar PV was installed in the small-scale market in 2017, which

was a record for the rooftop solar industry. Considerable growth also occurred in the medium-scale solar sector, with 131 projects adding 53 MW of new capacity. There is now 167 MW of cumulative capacity in the medium-scale solar sector, representing an increase of more than 500 per cent over the past five years.

The strong growth witnessed in the small- and medium-scale solar sectors has translated into increased employment opportunities, with the number of new Clean Energy Council Accredited Installers per month growing by 60 per cent in 2017.

Four new large-scale solar projects were completed in 2017, with the largest being the 50 MW plant built by Genex at Kidston in North Queensland. Total

installed large-scale solar capacity reached 450 MW at the end of 2017, which is a remarkable result considering that just 34 MW was installed at the end of 2014.

There was a tremendous amount of activity in the wind sector in 2017, with 15 new wind farms either under construction or financially committed at the end of the year. The 547 MW of new capacity added in 2017 was the third highest amount added in the history of the Australian wind industry, bringing total generation capacity across the country to 4816 MW.

For the first time ever, wind and hydro generation contributed an almost identical amount of electricity – approximately 5.7 per cent each – to total national electricity generation during the year.



Electricity prices were never far from the headlines in 2017, with significant price rises putting increasing pressure on households and businesses. While prices are expected to rise again in 2017-18, the Australian Electricity Market Commission predicts that residential electricity prices will fall 6.2 per cent on average over the following two years as more wind and solar generation comes online.

The installation of the world's largest lithium-ion battery in South Australia thrust energy storage into the spotlight in 2017. As well as storing energy from the nearby Hornsdale Wind Farm and pumping it back into the grid, the battery proved its mettle in December by helping to stabilise the grid after a large

coal-fired power station suddenly went offline.

In household storage, 12 per cent of the 172,000 PV installations in 2017 included a battery, up from 5 per cent in 2016. According to solar consultancy SunWiz, a total of 28,000 battery systems had been installed across Australia by the end of 2017. On a state-by-state basis, around 42 per cent of the nation's total storage installations are in New South Wales, with 19 per cent located in Queensland, 17 per cent in Victoria and 11 per cent in SA.

# ABOUT US

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 5000 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 through:

- > 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.

# 2017 SNAPSHOT

In 2017, approximately 700 MW of renewable projects were completed and began generation. But with seven times that amount either under construction or with financial support at the end of the year, this is just the beginning.

Although 2017 was a record year for the renewable energy sector, the percentage of renewable energy fell slightly from 17.3 per cent of Australia's electricity in 2016 to 17 per cent last year. This was largely because of a significant decline in hydro generation due to reduced rainfall in catchment areas.

For the first time ever, wind and hydro generation contributed an almost identical amount of electricity – each around 5.7 per cent of the national total – during the year.

Rooftop solar, which experienced its best ever year in 2017, continues to gain momentum thanks to growing interest from the commercial sector, as well as a growing number of households investing in solar panels. Last year, rooftop solar generated 3.4 per cent of Australia's power, a significant amount that was often produced when it was most needed – during the middle of hot summer days when every extra kilowatt

of power helped to ease the strain on the electricity network.

The big news in 2017 was the construction and commissioning of the world's largest lithium-ion battery at South Australia's Hornsdale Power Reserve. While this hit the headlines worldwide, it was just one of the many initiatives pursued or proposed by the South Australian state government as it led the race towards a 21st century energy system. What will happen following the change of government in March 2018 remains to be seen.

Household battery activity is accelerating around the country, but initiatives such as virtual power plants and other government incentives are helping to stimulate growth. As prices come down to a level where they become affordable for average home owners, large numbers of people are expected to invest in domestic battery storage systems.

While only a handful of large-scale solar projects were completed in 2017, it is remarkable to note that 450 MW of capacity has now been built across the country – up from just 34 MW at the end of 2014. Another 21 big solar projects were under construction at the beginning of 2018. Wind power also had its third-biggest year (547 MW of new capacity), with more than a dozen projects actively underway.

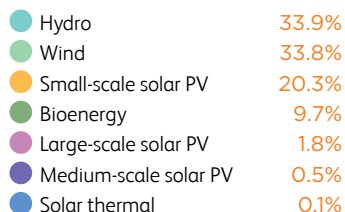
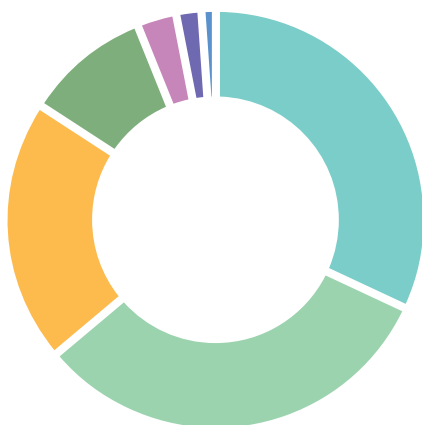
## RENEWABLE ENERGY GENERATION<sup>1</sup>

TECHNOLOGY	GENERATION (GWh)	PERCENTAGE OF RENEWABLE GENERATION	PERCENTAGE OF TOTAL GENERATION	EQUIVALENT NUMBER OF HOUSEHOLDS POWERED OVER COURSE OF THE YEAR
Hydro	12,920	33.9%	5.74%	2,811,140
Wind	12,873	33.8%	5.72%	2,800,914
Small-scale solar PV	7,723	20.3%	3.43%	1,680,412
Bioenergy	3,713	9.7%	1.65%	807,783
Medium-scale solar PV	197	0.5%	0.09%	42,959
Large-scale solar PV	695	1.8%	0.31%	151,243
Solar thermal	16	0.0%	0.01%	3383
Geothermal	1	0.0%	0.00%	152
<b>TOTAL</b>	<b>38,138</b>	<b>100%</b>	<b>16.94%</b>	<b>8,297,986</b>

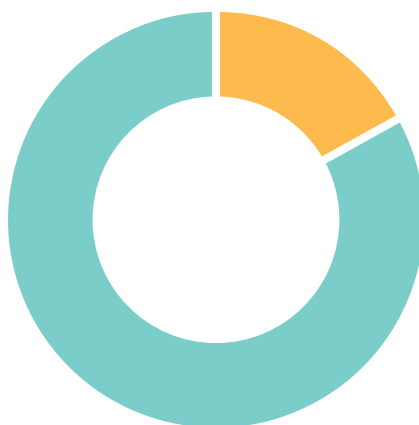
<sup>1</sup> NEM Watch, *Australian Energy Statistics 2017*, ARENA, Clean Energy Council Renewable Energy Database, SunWiz. Note: some figures have been rounded. Figures do not include auxiliary load or transmission losses. Electricity generation equivalent in households is calculated using a weighted national average consumption level of 4.596 MWh (from AEMC, *2017 Residential Electricity Price Trends*, 18 December 2017).



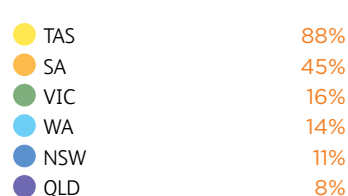
### RENEWABLE GENERATION BY TECHNOLOGY TYPE<sup>2</sup>



### ANNUAL ELECTRICITY GENERATION IN 2017<sup>2</sup>



### RENEWABLE ENERGY PENETRATION BY STATE<sup>3</sup>



### RENEWABLE ENERGY PENETRATION BY STATE<sup>3</sup>

STATE	TOTAL GENERATION (GWh)	FOSSIL FUEL GENERATION (GWh)	TOTAL RENEWABLE GENERATION (GWh)	PENETRATION OF RENEWABLES
TAS	10,361	1,208	9,153	88%
SA	13,243	7,252	5,991	45%
VIC	49,610	41,622	7,988	16%
WA	19,095	16,371	2,724	14%
NSW	67,932	60,601	7,331	11%
QLD	64,840	59,856	4,984	8%
NATIONAL	225,082	186,910	38,172	17%

<sup>2</sup> NEM Watch, *Australian Energy Statistics 2017*, ARENA, Clean Energy Council Renewable Energy Database, SunWiz.

<sup>3</sup> 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 for the small NT grid. Some of the Snowy Hydro Scheme in NSW is counted as Victorian generation by AEMO. Note: These figures are not the same as the total electricity generation as non-scheduled and off-grid generators are not included in this data (other than domestic solar). Source: NEM Watch, SunWiz, Clean Energy Regulator.

# 2017 SNAPSHOT CONTINUED

## RENEWABLE ENERGY PROJECTS COMPLETED IN 2017

TECHNOLOGY	STATE	OWNER	PROJECT	CAPACITY (MW)
Bioenergy	WA	Worsley Alumina Refinery	Worsley Multi Fuel Cogeneration Plant	114
Bioenergy	QLD	Tong Park Piggery	Tong Park	1
Bioenergy	VIC	Yarra Valley Water	Rewaste Wollert	1
Hybrid	SA	EDL	Coober Pedy Renewable Hybrid Project	5
Hydro	QLD	Seqwater	Lake Somerset	4
Solar PV	QLD	Genex	Kidston	50
Solar PV	QLD	Sunshine Coast Regional Council	Sunshine Coast Solar Farm	15
Solar PV	QLD	Conergy	Lakeland Solar and Storage	13
Solar PV	NSW	Goldwind Australia/BJC	Gullen Range Solar Farm	10
Solar PV/ Bioenergy	SA	North Adelaide Waste Management Authority	NAWMA	2
Solar thermal	NSW	Vast Solar	Jemalong CSP Pilot	1
Wind	VIC	RES	Ararat Wind Farm	240
Wind	SA	Neoen/Megawatt Capital	Hornsdale Stage 2	109
Wind	SA	Neoen/Megawatt Capital	Hornsdale Stage 3	100
Wind	VIC	Windlab	Kiata Wind Farm	31
Wind	TAS	Hydro-Electric Corporation	Whitemark Power Station	4

16  
renewable energy projects  
completed in 2017

34  
renewable energy projects under  
construction at the end of 2017

701  
megawatt capacity

2563  
megawatt capacity

## RENEWABLE ENERGY PROJECTS UNDER CONSTRUCTION AS OF 31 DECEMBER 2017<sup>4</sup>

TECHNOLOGY	STATE	OWNER	PROJECT	CAPACITY (MW)
Bioenergy	QLD	MSF	Tableland Mill	24
Solar PV	SA	Reach Solar	Bungala	220
Solar PV	QLD	ESCO Pacific/Palisade	Ross River	148
Solar PV	QLD	Sun Metals	Sun Metals Solar Farm	116
Solar PV	NSW	Lighthouse Solar	Clare	100
Solar PV	QLD	RES	Emerald	72
Solar PV	QLD	Edify/Wirsol	Hamilton	58
Solar PV	QLD	Edify/Wirsol	Whitsunday	58
Solar PV	NSW	First Solar/Infigen	Manildra	49
Solar PV	QLD	RATCH-Australia	Collinsville	42
Solar PV	NSW	Neoen	Dubbo	25
Solar PV	QLD	Canadian Solar	Oakey	25
Solar PV	WA	APA Group	Emu Downs	20
Solar PV	QLD	Lighthouse Solar	Hughenden	20
Solar PV	NSW	Goldwind Australia	White Rock	20
Solar PV	QLD	Windlab/Eurus	Kennedy Energy Park	19
Solar PV	QLD	Canadian Solar	Longreach	15
Solar PV	QLD	Ydot Projects	Dunblane Solar Farm	11
Solar PV	WA	Carnegie/Lend Lease	Northam	10
Solar PV	NSW	Pamada	Upper Hunter Energy Park	10
Solar PV	SA	SSE Australia	Whyalla Solar Farm Stage 1	6
Solar PV	QLD	Canadian Solar/Scouller Energy	Normanton	5
Wind	NSW	CWP Renewables	Sapphire	270
Wind	NSW	AGL	Silverton	199
Wind	QLD	RATCH-Australia	Mt Emerald (Arriga)	181
Wind	NSW	Goldwind Australia	White Rock	175
Wind	VIC	ACCIONA	Mt Gellibrand	132
Wind	SA	Engie	Willogoleche Hill	119
Wind	NSW	Infigen	Bodangora (Wellington)	113
Wind	NSW	Global Power Generation	Crookwell 2 (Goulburn)	91
Wind	VIC	Pacific Hydro	Crowlands	80
Wind	VIC	Tilt Renewables	Salt Creek	58
Wind	QLD	Windlab/Eurus	Hughenden	43
Wind	VIC	Pacific Hydro	Yaloak	29

<sup>4</sup> Clean Energy Council Renewable Energy Database, Clean Energy Council Member Survey, SunWiz Large-scale Lookout, AEMO.



> 6000

megawatts of  
large-scale generation  
needed by 2019 to  
meet the RET

6532

megawatts of  
large-scale generation  
announced between  
2016 and January 2018

Image: Weipa Solar Farm, Queensland

# INDUSTRY GEARS UP TO MEET THE RENEWABLE ENERGY TARGET

Early in 2018, the Clean Energy Regulator (CER) announced that there were enough projects at a sufficiently advanced stage to meet the large-scale Renewable Energy Target (RET).<sup>5</sup>

The CER has previously estimated that approximately 6000 MW of large-scale generation capacity would need to be announced and built between 2016 and 2019 to meet the target of 33,000 GWh of additional renewable energy by the end of the decade.

There has been 6532 MW of new large-scale generation firmly announced between 2016 and the time of the CER announcement in January 2018.

The majority of this is either under construction or already operating. The rest is expected to begin construction in 2018.

The combination of a stable federal RET and state government renewable energy schemes provided a strong incentive for new project development in 2017. Figures collated by the Clean Energy Council at the end of the year found the projects under construction, completed or that had attracted finance in 2017 added up to \$10 billion of investment, more than 5300 MW of generating capacity and almost 5750 new direct jobs.

Between the large-scale and rooftop solar sectors approximately \$12 billion of new private investment was generated in 2017 from domestic and international capital.

The success of the RET in encouraging major new investment has shown that the key to success lies in developing an effective policy and leaving it alone to let the market work. With renewable energy now the lowest-cost type of new energy generation it is possible to build, the industry has an excellent foundation for continued success.

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<sup>5</sup> Clean Energy Regulator, media release, *Record year of investment means Australia's 2020 Renewable Energy Target will be met*, 23 January 2018.



JOBS AND  
INVESTMENT  
IN RENEWABLE  
ENERGY  
**BY STATE**

# LARGE-SCALE RENEWABLE ENERGY PROJECTS UNDER CONSTRUCTION OR STARTING IN 2018

**30**  
Megawatts  
**\$67m**  
Investment  
**100**  
Jobs

**WA**

**NT**

**QLD**

**SA**

**1111**  
Megawatts  
**\$2850m**  
Investment  
**1080**  
Jobs

**VIC**

**116**  
Megawatts  
**\$280m**  
Investment  
**200**  
Jobs

\* As at April 2018

**2121**  
Megawatts  
**\$4091m**  
Investment  
**3196**  
Jobs

**1055**  
Megawatts  
**\$2214m**  
Investment  
**1175**  
Jobs

**1166**  
Megawatts  
**\$1688m**  
Investment  
**330**  
Jobs

## TOTALS

**5600**  
Megawatts

**\$11,190m**  
Investment

**6080**  
Jobs

D

ISW

TAS





Image: Kidston Solar Farm, Queensland

# INDUSTRY OUTLOOK

## OUTLOOK FOR SMALL-SCALE RENEWABLE ENERGY

2017 was a record-breaking year for rooftop solar, with almost 1.1 GW of rooftop PV installed in the small-scale market.

And with power prices increasing further, it is safe to say the outlook is positive, with many of the fundamentals in place for another very strong year for the solar industry.

Australian businesses are finding it difficult to secure affordable long-term contracts for their electricity, making solar and storage increasingly attractive options – particularly with the range of finance options that are now available. This medium-scale section of the market has been driving a large part of

the growth over the last few years.

In addition, households in outer suburbs and regional towns will continue to turn towards small-scale renewable energy to help protect them from future price hikes.

Solar consultancy SunWiz says that with electricity prices set to remain high, good momentum in the sector and a robust market, the residential and SME market is “primed to continue” at more than 1.2 GW in 2018.<sup>6</sup>

Combined with a record construction year for the large-scale part of the market, solar is well positioned to be the new goldrush out to 2020 and beyond.

### Six key factors that will influence solar PV in 2018<sup>7</sup>:

1. Electricity prices and feed-in tariffs
2. The rate that electricity prices are rising
3. PV system prices
4. Awareness
5. Momentum
6. Market robustness

## CASE STUDY

### MOOROOLBARK COMMUNITY MINI-GRID



To the casual observer, the Melbourne suburb of Mooroolbark is just like any other middle-class commuter region, but something unique is happening in one tree-lined street.

In a ground-breaking trial, AusNet Services worked with Greensync – who built, operated and maintain the smart solar-storage home systems – and PowerTec – who manage the smooth

separation and stabilisation of the system – on a community mini-grid using solar panels and batteries.

The trial included a series of scenarios to test how renewable and community energy projects can be efficiently integrated into the network, and the benefits they can bring to both consumers and the electricity grid.

The first test was conducted in May 2017 and involved successfully separating eight homes from the grid – six with solar and storage, two without – and operating them as a stand-alone solar and battery storage powered mini-grid.

Towards the end of 2017, AusNet took a group of 17 houses off-grid for a total of nine hours, powered only by the collective solar and battery storage systems installed on 14 of the homes.

The project not only demonstrated the effectiveness of residential renewable power, but it could also lead to considerable savings for consumers.

The Mooroolbark mini-grid trial was a joint winner of the 2017 Clean Energy Council Innovation Award.

6 W Johnston, *Renew Economy, 2018: Can Australian PV keep up record-breaking pace set in 2017?*, 15 January 2018 <http://reneweconomy.com.au/2018-can-australian-pv-keep-record-breaking-pace-set-2017/> (accessed 6 March 2018).

7 Ibid.

## STATE RENEWABLE ENERGY POLICES

At the end of 2017, no national climate or energy policy was in place to encourage affordable, reliable and clean electricity after 2020.

Consequently, state governments have introduced a variety of policies to maximise their share of the billions of dollars in investment on offer from renewable energy, as well as helping to reduce emissions. Debate and policy development will continue throughout 2018 on the Federal Government's proposed National Energy Guarantee (NEG).

The fate of the policy is far from assured after a decade of acrimonious political debate and destabilisation in this area.

While a strong and consistent national policy would be preferable to navigating a patchwork of individual jurisdictions, these state and territory policy measures have been crucial to driving new investment in the absence of federal policy leadership.



Image: Woodlawn Wind Farm, New South Wales

# INDUSTRY OUTLOOK CONTINUED

100%

of energy in the ACT to come from renewable sources by 2020

640

megawatts of power from four reverse auctions held between 2012 and 2016

11

large-scale solar projects approved by the NSW government in 2017

## AUSTRALIAN CAPITAL TERRITORY

The ACT has the most ambitious renewable energy target in the country, and is on track to deliver on its goal of 100 per cent clean energy well before its 2020 deadline.

Four reverse auctions formed the centrepiece of its plan to meet the target – one for solar and three for wind. This process invited companies to bid on the construction of new wind and solar projects for the lowest cost, resulting in the best possible deal for taxpayers and the ACT Government.

The ACT was the first state or territory to run a reverse auction scheme for new renewable energy, an idea that has since sparked interest in other jurisdictions. The first reverse auction for 40 MW of large-scale solar projects was held in 2012 and 2013, followed by three 200 MW wind power reverse auctions in 2014, 2015 and 2016.

The feed-in tariffs awarded as part of the auctions are fixed for 20 years, helping to protect Canberra residents from sharp rises in wholesale electricity prices.

The last project to be built under the scheme will be Union Fenosa's Crookwell 2 Wind Farm, which is due for completion in the second half of 2018. All the other projects have now been completed.

The ACT also supported the installation of household battery storage through a competitive grants process, which started in early 2016 with the government awarding three grants of \$200,000 to support the installation of battery storage in 200 Canberra homes and businesses. The Next Generation Energy Storage Grants are facilitating one of the largest rollouts of household batteries in the world.

## NEW SOUTH WALES

Although NSW does not have a specific renewable energy target, the state government has set a long-term target for NSW to have zero net emissions by 2050, including in its energy sector.

As part of this goal, the government's Climate Change Fund Strategic Plan aims to double the state's level of renewable energy capacity to more than 10,000 MW by 2021.

NSW was one of the leading states for new large-scale renewable energy projects at the beginning of 2018, with the government approving 11 large-scale solar energy plants in the previous 12 months. Notable projects currently under construction or beginning in 2018 include the 170 MW Finley Solar Project in the Riverina, which will include half a million solar panels, the 270 MW Sapphire Wind Farm in New England and the co-located White Rock Wind and Solar Farms, which will generate almost 400 MW of renewable energy upon completion.



# 25%

of energy in Victoria to come from renewable sources by 2020, rising to 40% by 2025

## VICTORIA

The Victorian Government has committed to two renewable energy targets: 25 per cent by 2020 and 40 per cent by 2025.

This will be supported by the Victorian Renewable Energy Auction Scheme, a reverse auction to fund 650 MW of new renewable energy, with 100 MW of this specifically for large-scale solar. The scheme is the largest renewable energy reverse auction in Australia and will result in a significant increase in renewable energy projects in Victoria.

It is a condition of the auction that the successful projects will begin commercial operation before the last quarter of 2020, with an overarching goal of reducing emissions by 16 per cent by 2035.

# 650

megawatts of power from a reverse auction, with 100 MW for large-scale solar

The Victorian Government has also announced the outcome of tenders under its Renewable Certificate Purchasing Initiative, which involves the government procuring renewable energy certificates directly from new Victorian projects. The 31 MW Kiata Wind Farm and the 132 MW Mt Gellibrand Wind Farm were the successful projects under the first stage of the initiative, while the 88 MW Bannerton Solar Park and 34 MW Numurkah Solar Farm were awarded tenders under the second stage of the competitive tender process.

Some of the generation from these solar projects will be used to offset the power used by Melbourne's tram network.

# 50%

of energy in the Northern Territory to come from renewable sources by 2030

## NORTHERN TERRITORY

The Northern Territory has set itself a target of 50 per cent renewables by 2030, an ambitious expansion considering that renewables only accounted for 4 per cent of its power generation in 2017.

In late 2017, an independent expert panel produced the Roadmap to Renewables report, which provided 11 recommendations on how the NT Government can achieve its target. These included making renewable energy a central pillar of the NT Government's economic policy and a series of other financial, regulatory and technical recommendations. Meeting the 50 per cent renewable energy target will allow NT to move away from its reliance on gas and diesel, which currently accounts for 96 per cent of its energy generation.

**100%**

potential increase in capacity in Tasmania under the 'Battery of the Nation' plan

## TASMANIA

With its extensive hydro power network supplying more than 90 per cent of the state's energy needs, Tasmania has traditionally been Australia's renewable energy leader.

In April 2017, Hydro Tasmania announced its 'Battery of the Nation' plan, which 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. The plan also calls for a second interconnector to be constructed to allow the state to export its surplus energy to the National Electricity Market (NEM). The Battery of the Nation concept is currently undergoing feasibility studies, but is an exciting prospect for an extensive increase in Tasmania's renewable energy capacity.

A number of new wind farms are under development in Tasmania, with the state's north-west being touted as 'Australia's wind farm capital'. The Robbins Island Renewable Energy Park is a proposal

for a 450 MW project, with the possibility of being expanded to 1000 MW if a second interconnector is built to the mainland. This would make the wind farm the largest in the Southern Hemisphere. Construction is underway at the 112 MW Granville Harbour and 150 MW Cattle Hill Wind Farms. The Jim's Plain Renewable Energy Park will consist of up to 160 MW of wind, battery storage and other infrastructure.

Energy policy was one of the key issues during the Tasmanian state election, which was eventually won by incumbent Premier Will Hodgman's Liberal Party. During the campaign, the Liberal government made commitments to increase Tasmania's renewable generation by 1000 GWh by 2022 and promised to reduce power prices by decoupling Tasmanian electricity prices from the benchmarks set by the NEM.

**1000**

megawatts of wind and solar projects seeking approvals in Western Australia in 2017

## WESTERN AUSTRALIA

Western Australia has traditionally lagged behind the eastern states when it comes to renewable energy, but during 2017 more than 1000 MW of wind and solar projects were seeking connection approvals and finance in the state's south-west.<sup>8</sup> However, WA continues to be the only state or territory in Australia that hasn't committed to a target for renewable energy or zero net emissions.

In late 2017, the WA government announced that state-owned power utility Synergy will set up a green power fund with investment from the Dutch Infrastructure Fund. This is expected to work similarly to the Powering Australian Renewables Fund set up by AGL, by providing an opportunity for investors to finance a portfolio of renewable assets to diversify risk and reduce costs.

The Australian Energy Market Operator estimates that another 700 MW of new renewable energy capacity will be required to meet WA's share of the Renewable Energy Target, and Western Power

<sup>8</sup> G Parkinson, *Renew Economy, Lower the drawbridge! WA prepares for wind and solar boom*, 20 June 2017 <http://reneweconomy.com.au/lower-the-drawbridge-wa-prepares-for-wind-and-solar-boom-48290/> (accessed 11 April 2018).



# 45%

of South Australia's electricity came from renewable sources in 2017

# \$100M

committed by the South Australian Liberal Party to a household battery program offering means-tested grants

## SOUTH AUSTRALIA

estimated in mid-2017 that more than 1000 MW of new projects are in the pipeline.

While Labor made promises to expand the state's renewable energy uptake during the 2017 election campaign, Premier Mark McGowan and Energy Minister Ben Wyatt have moved slowly on announcing any state-based renewable energy target or energy policy, but are coming under increased pressure to do so.<sup>9</sup>

South Australia set an aspirational target of 50 per cent renewable energy by 2025, which it had almost achieved in 2017, with 45 per cent of the state's electricity coming from renewable sources.

In March 2018 after 16 years of Labor in power, the state elected a Liberal government. The effect that this will have on renewable energy in the state is yet to be determined.

The Liberal party's election campaign focused on:

- affordable electricity
- reliable renewable energy
- empowering consumers
- better value for taxpayers
- developing stronger connections between South Australia and the National Electricity Market.

It also promised a reduction of \$302 a year in the average household power bill.

Two key elements of its energy policy were a \$200 million interconnection fund to improve

connectivity with the National Electricity Market and a \$100 million household battery program offering means-tested grants.

The new Premier promised support for storage at the household level, and pledged to build a new interconnector to New South Wales. He has also backed the solar thermal plant planned for Port Augusta.

Electranet is conducting extensive analysis about whether the proposed transmission line to NSW will be a positive for South Australia. Its report is due in June 2018.

The clean energy industry would like to recognise outgoing Premier Jay Weatherill and his government, whose proactive approach to securing private investment for South Australia was critical to transitioning the state toward a cleaner, more reliable and affordable energy system.

Image: Gordon Hydroelectric Power Station, Tasmania

<sup>9</sup> G Philipson, Government News, *WA urged to go it alone on renewables*, 5 November 2017 <https://www.governmentnews.com.au/2017/11/wa-urged-go-alone-renewables/> (accessed 11 April 2018).

# INDUSTRY OUTLOOK CONTINUED

**50%**

of energy in Queensland to come from renewable sources by 2030

## QUEENSLAND

The Sunshine State has set a 50 per cent renewable energy target by 2030, and with Labor being returned to office in 2017, the state government is working towards achieving it.

In 2017, 8 per cent of Queensland's electricity came from renewables, underlying the scale of the job at hand. But a variety of policies and programs support the government's ambition, complementing the federal Renewable Energy Target and other initiatives from the Australian Renewable Energy Agency. All this is leading to a great deal of project activity.

Several areas of the state have emerged as large-scale solar hubs, including Townsville in North Queensland and the Darling Downs west of Toowoomba.

As part of its \$1.16 billion Powering Queensland plan, the government's Renewables 400 initiative held a reverse auction for up to 400 MW of new renewable energy capacity, including 100 MW of new storage. Renewables 400 attracted 115 proposals from 79 businesses, adding up to more than 9000 MW of new capacity – more than 20 times the amount needed. In a media statement, Energy Minister Mark Bailey said the proposals added

up to more than the current 8200 MW generated by coal-fired power stations and was "further proof that Queensland does not need a new coal-fired power station".<sup>10</sup> The successful applicants will be announced in 2018.

Queensland already has the largest number of rooftop solar installations of any state or territory, as well as eight of the top 10 solar postcodes in the country. Solar owners in regional areas have the option of being paid a time-varying feed-in tariff, which can pay them more during times when electricity is in short supply.

<sup>10</sup> M Bailey, Queensland Government media release, 'Renewables 400' accelerates Queensland's clean energy boom, 11 October 2017.



“We were surprised at the prices we saw for wind, and shocked at the prices we saw for solar”

- Meridian CEO Ed McManus, commenting on the low price of renewable energy when negotiating PPAs for Powershop, Meridian’s retail arm

## RENEWABLE ENERGY COSTS CONTINUE TO FALL

The cost of renewable energy in power purchasing agreements (PPAs) continues to fall, making it a highly competitive option for businesses seeking contracts for energy supplies.

During 2017, Origin Energy sold the Stockyard Hill Wind Farm to Goldwind Australia for \$110 million and agreed to buy all the power generated by it for less than \$60/MWh.<sup>11</sup>

Meridian Energy signed up for more than twice the amount of renewable energy it had intended in early 2018 while negotiating PPAs for its retail business Powershop Australia. Powershop CEO Ed McManus said while he couldn’t reveal the price of the deal, “we were surprised at the prices we saw for wind, and shocked at the prices we saw for solar”.

Asked whether the PPA prices matched recent reports regarding Stockyard Hill or the sub-\$70/MWh reported for solar, Mr McManus said they were “at or below what had been reported in the media as one-offs”.<sup>12</sup>

These kinds of arrangements will make renewable energy a more attractive financial option for businesses.

## LONG-TERM ENERGY AND CLIMATE POLICY

Australia’s banks, businesses, major energy institutions and many governments have begun planning for a renewable energy future, but there is still no long-term unifying energy or climate policy in place.

In June 2017, Chief Scientist Dr Alan Finkel delivered a suite of 50 recommendations to improve Australia’s energy security, which became known in industry circles as ‘The Finkel Report’. The government moved quickly to adopt 49 of these, but ultimately voted to reject the primary recommendation – the introduction of a Clean Energy Target to take effect beyond 2020.

The policy had won the support of the energy sector, the business community, the clean energy industry and the federal Labor Party. It was, however, a backbench revolt within the government itself that ultimately killed off the idea.

In place of a Clean Energy Target, the Federal Government has proposed a National Energy Guarantee (NEG) that it claims will tackle the three big issues around energy: reliability, affordability and reduced emissions. However, the

policy development and consultation process was still very much underway in the first quarter of 2018.

Given the significant uncertainty and relatively low level of ambition on clean energy and emissions reduction from the Federal Government, many state governments have introduced their own policies and targets. This will help to secure job and investment benefits from renewable energy projects as well as helping Australia to meet its emission reduction commitments.

11 S Vorrath and G Parkinson, Renew Economy, *Origin stuns industry with record low price for 530MW wind farm*, 8 May 2017 <http://reneweconomy.com.au/origin-stuns-industry-with-record-low-price-for-530mw-wind-farm-70946/> (accessed 6 March 2018).

12 G Parkinson, Renew Economy, *Powershop signs huge deal for solar, wind projects - “stunned” by low prices*, 1 February 2018 <https://reneweconomy.com.au/powershop-signs-huge-deal-for-solar-wind-projects-stunned-by-low-prices-11533/> (accessed 11 April 2018).

# EMPLOYMENT

Increased confidence has resulted in an unprecedented level of industry activity. The rooftop solar sector has reported a shortage of qualified electricians in some areas.

The sector began 2017 confident that the policy uncertainty caused by the Abbott Government's review of the Renewable Energy Target (RET) was in the past. And that confidence continued to soar, delivering a record year for projects in large-scale wind and solar as well as the rooftop solar sector.

By the end of 2017, many established solar retailers were reporting that the increased level of activity sometimes made it difficult to find enough qualified electricians to complete all the work that was coming in, and these market conditions helped trigger a steady increase in the number of accredited solar installers.

Having more work than your industry can handle is mostly a good problem to have, but it is one of the challenges that many solar businesses are actively managing due to the record year.

By the end of 2017, the number of installers accredited with the Clean

Energy Council had grown to 4941. This was slightly more than the 4824 registered at the end of 2012, which was the previous highest year for the sector. The number of new accredited installers per month increased by 60 per cent in 2017 compared to the year before.

If the demand for solar continues throughout 2018 – and many of the factors that drove the strong results in 2017 are still in place – the level of opportunity will lead to more electricians doing the necessary training to expand into the solar sector.

Increased project activity for large-scale wind and solar also resulted in a growing number of jobs in regional areas across the country.

It is expected that the unprecedented level of industry activity will create major job opportunities and lead to a substantial boost in numbers during the next few years as the industry builds out the RET.

## AVERAGE NEW CLEAN ENERGY COUNCIL-ACCREDITED INSTALLERS REGISTERED PER MONTH

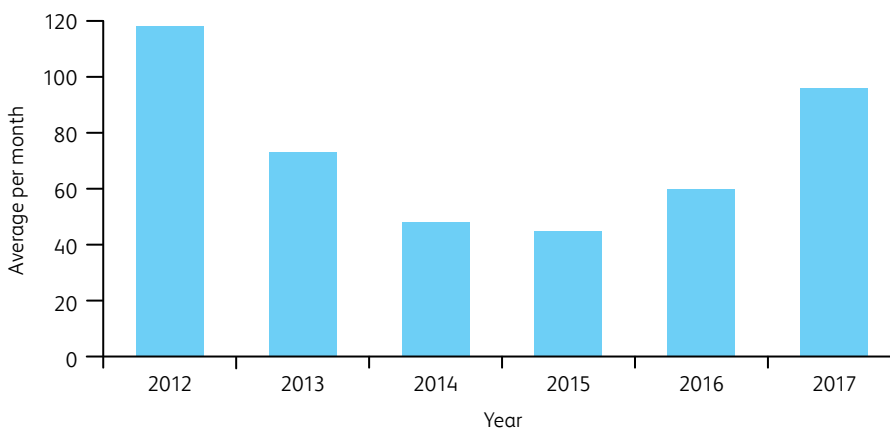




Image: Commercial solar installation, New South Wales

# INVESTMENT



## US\$9B

investment  
in large-scale  
wind and solar  
projects  
in Australia –  
a new record

## 150%

increase in  
investment  
in 2017

According to Bloomberg New Energy Finance data, large-scale wind and solar project activity pushed investment in Australia up 150 per cent to a record US\$9 billion in 2017.

Several factors have contributed to this spike in investment:

- the extraordinary cost reductions achieved in renewable energy
- the stability and incentives provided by the 2020 Renewable Energy Target (RET)
- additional support from the Australian Renewable Energy Agency and the Clean Energy Finance Corporation
- various state and territory government initiatives.

Globally, clean energy investment amounted to US\$333.5 billion last year. This was 3 per cent higher than 2016 and the second highest annual figure ever – just 7 per cent less than the record figure of US\$360.3 billion reported in 2015.

China and the US led the way with investments reaching US\$136.2 billion and US\$56.9 billion respectively. Renewable energy investments across Europe fell in the face of uncertain policy support.<sup>13</sup>

<sup>13</sup> Bloomberg New Energy Finance, *Runaway 53GW Solar Boom in China Pushed Global Clean Energy Investment Ahead in 2017*, 16 January 2018 <https://about.bnef.com/blog/runaway-53gw-solar-boom-in-china-pushed-global-clean-energy-investment-ahead-in-2017/> (press release accessed 6 March 2018).

# US\$333.5B

total worldwide investment in renewable energy in 2017

# 3%

increase in investment in 2017

# US\$136.2B

Chinese investment in renewable energy in 2017

# US\$56.9B

US investment in renewable energy in 2017

In terms of investment by the sector worldwide, solar led the way, with an impressive 48 per cent of all clean energy investment. Wind and energy-smart technologies, such as battery storage and smart meters, occupied second and third place respectively.

## CASE STUDY

### WOMEN IN RENEWABLES

The Clean Energy Council has continued its commitment to supporting and encouraging female representation in the industry through its Women in Renewables initiative.

Three key programs have been introduced to target women at all stages of their career: the Women in Renewables Scholarship, Leaders' Pledge and Speakers Guide.

The 2017 Women in Renewables Scholarship was awarded to Vanessa Ratard, Senior Project Manager with the remote engineering firm Ekistica.

Among her many achievements, Ms Ratard led the development of the *Hybrid Power Generation for Off-Grid Mines* handbook for the Australian Renewable Energy Agency.

Ms Ratard said the scholarship would allow her to be a champion for women in renewable energy, as well as play her part in bridging the gender gap in the renewables industry.

Now in its third year, the scholarship provides support for a woman from a Clean Energy Council member company to complete the Australian Institute of Company Directors' Foundations of Directorship course.

The Leaders' Pledge demonstrates the commitment of individuals and companies to the value and importance of gender diversity. Anyone who self-identifies as a leader

can sign the pledge and make a commitment to being inclusive and promoting the successes of women. More than 170 people have signed the pledge so far and are striving to shape both the future workplace and more diverse speaking panels and events across Australia.

In support of the Clean Energy Council's commitment to the Leaders' Pledge, we have also compiled the industry's first Speakers Guide, highlighting the breadth of talented women speakers from the renewables industry. For more information, visit [cleanenergycouncil.org.au/women](http://cleanenergycouncil.org.au/women).



# ELECTRICITY PRICES



11%

national rise in wholesale electricity power prices in 2017

\$1424

average annual electricity bill in 2016-17

7%

proportion of average electricity bill made up of environmental costs

Affordability challenges continue across the National Electricity Market, following significant price rises over the past decade.

While electricity prices are expected to increase further in 2017-18, there is relief in sight. The Australian Electricity Market Commission (AEMC) predicts residential electricity prices will fall 6.2 per cent on average over the following two years as more wind and solar generation comes online.<sup>14</sup>

According to the AEMC, the national average annual residential electricity bill in 2016-17 was \$1424, up from \$1296 in the previous financial year. The prediction for 2017-18 is a further rise to \$1576, before falling to \$1495 in 2018-19 and \$1387 in 2019-2020.<sup>15</sup>

The AEMC found wholesale electricity costs – the cost of generating power – has been the single biggest driver of residential electricity bill increases recently. Earlier price trend reports had identified network costs as the main upward driver. High gas prices and the closure of several coal-fired plants combined to lift wholesale electricity prices by almost 11 per cent nationally.

Insufficient new power generation over the past decade, primarily due to chronic policy uncertainty, has resulted in increased prices. New supply has failed to keep up with demand.

Electricity prices are made up of four main components: network costs (the poles and wires), generation costs (traditional or renewable), retail margins and environmental costs (primarily meeting the RET and covering solar feed-in tariffs).

In March 2017, Federal Treasurer Scott Morrison directed the Australian Competition and Consumer Commission (ACCC) to hold an inquiry into the retail supply of electricity and the competitiveness of retail electricity markets.

In its preliminary report, released in September 2017, the ACCC found that the average 2015–16 residential electricity bill was \$1524 (significantly more than the AEMC's reported \$1296) and was made up of: 48 per cent network costs, 22 per cent wholesale costs, 24 per cent retail and other costs (including margins) and 7 per cent environmental costs.<sup>16</sup>

A report by the Australian National University showed that between 2006 and 2016, electricity price rises were highest in the states with relatively low levels of renewable energy and a high reliance on gas and/or coal generation (136 per cent in Queensland, 118 per cent in Victoria and 109 per cent in New South Wales). In contrast, South Australia, which now generates almost half of its energy from renewables, experienced a far lower electricity price rise (87 per cent) over the same period (see chart on page 32).

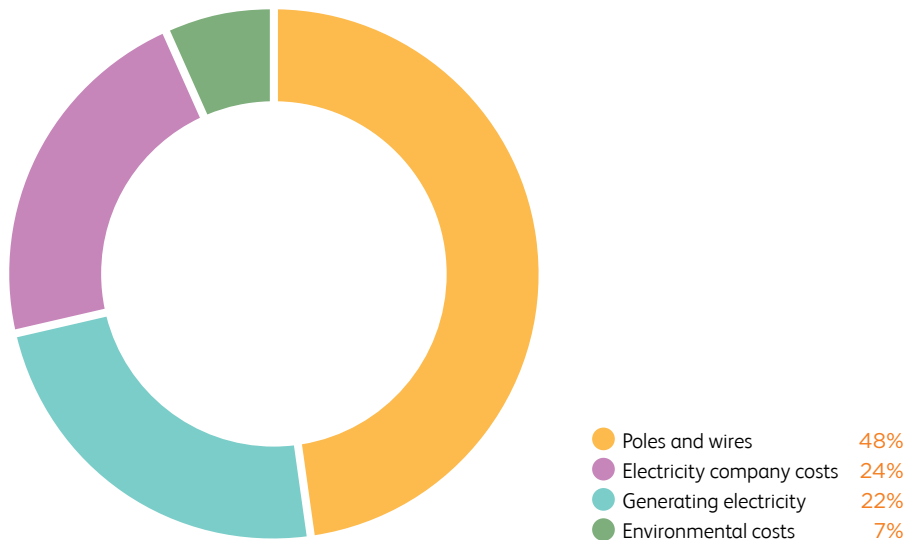
Despite a vocal minority suggesting that the RET is the main reason for the increase in electricity pricing, this is simply not the case. In fact, the single biggest contributor to rising electricity prices is the increasing cost of gas.

14 Australian Energy Market Commission, *2017 Residential Electricity Price Trends*, December 2017, p 173.

15 Ibid.

16 Australian Competition and Consumer Commission, *Retail Electricity Pricing Inquiry Preliminary report*. September 2017, p 6.

## BREAKDOWN OF CHARGES IN DOMESTIC ELECTRICITY BILLS, 2015-16<sup>16</sup>



Analysis released last year suggests that Australians pay more to use the gas from our own reserves than the residents and businesses in countries to which we export.<sup>17</sup>

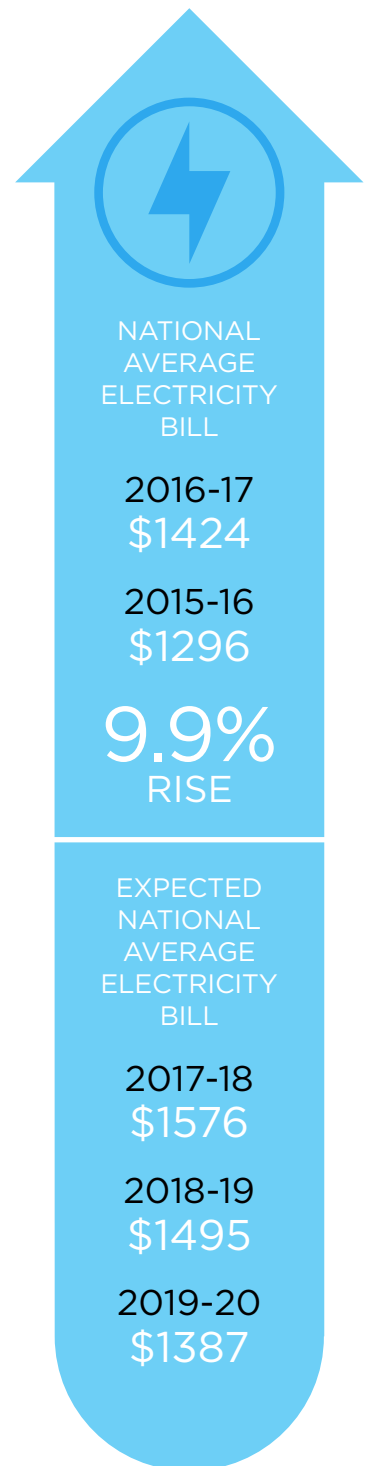
A range of other factors have contributed to price rises, including:

- A lack of national energy policy beyond 2020. This means business does not have the necessary certainty to invest in the new infrastructure.
- Increased charges by energy retailers for winning and billing customers.
- The retirement of coal-fired power stations with not enough new power generation to replace them.
- Game-playing by power plant operators in the wholesale electricity market and not enough competition to help reduce prices.

- Complicated consumer information making it hard for people to easily understand the options they have available and make smart choices to reduce their bills.

The good news is that with the ACCC's final report due out this year, there is likely to be political pressure to find practical, viable and meaningful measures to ease the burden on Australian households and businesses.

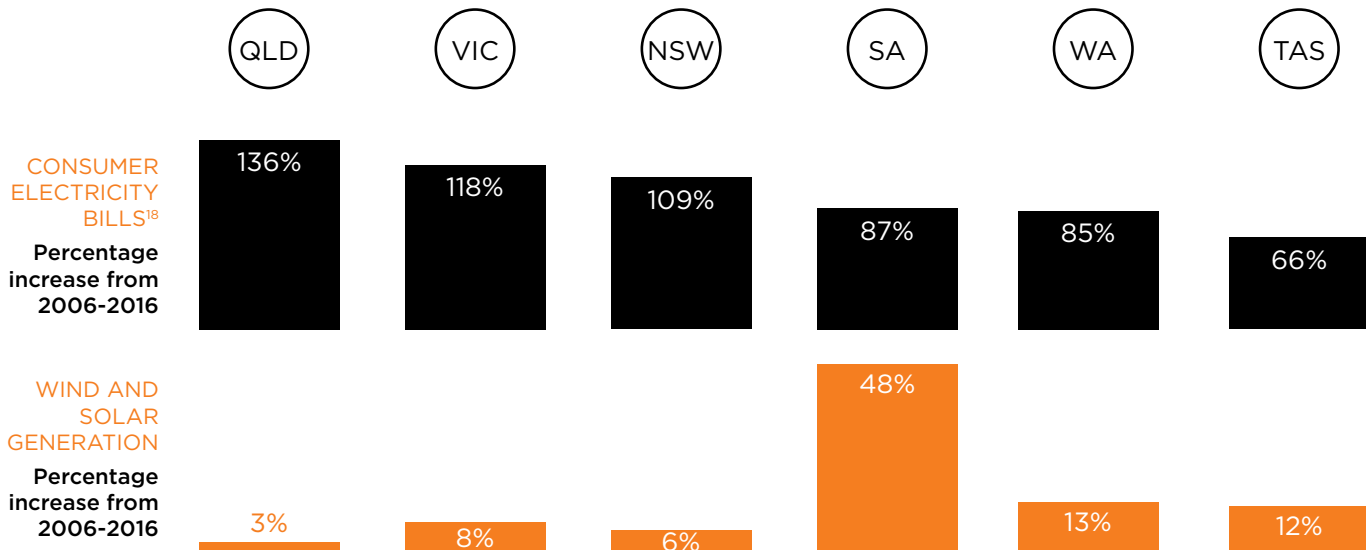
Coupled with better affordability of small-scale solar panels and battery storage, this should reduce costs for consumers and increase the flexibility of the national grid.



<sup>17</sup> I Verrender, ABC Online, *The truth about soaring power prices: wind and solar not to blame*, 25 September 2017 <http://www.abc.net.au/news/2017-09-25/the-truth-about-soaring-power-prices/8979860>, (accessed 7 March, 2018).

# ELECTRICITY PRICES CONTINUED

## POWER PRICE INCREASES VS POWER FROM WIND AND SOLAR



## NATIONAL SUMMARY OF SUPPLY CHAIN COST COMPONENTS<sup>19</sup>

	2016-17 BASE YEAR		2017-18 CURRENT YEAR		2018-19		2019-20	
	c/kWh	\$/year	c/kWh	\$/year	c/kWh	\$/year	c/kWh	\$/year
<b>Residual</b>	<b>2.52</b>	<b>\$116</b>	<b>2.87</b>	<b>\$132</b>	<b>2.95</b>	<b>\$135</b>	<b>3.03</b>	<b>\$139</b>
<b>Environmental policies</b>	<b>2.01</b>	<b>\$92</b>	<b>1.62</b>	<b>\$74</b>	<b>1.78</b>	<b>\$82</b>	<b>1.93</b>	<b>\$89</b>
LRET - LGC cost	0.65	\$30	0.76	\$35	0.89	\$41	1.03	\$47
SRES - STC cost	0.36	\$17	0.32	\$15	0.34	\$15	0.32	\$15
FIT schemes	0.85	\$39	0.37	\$17	0.37	\$17	0.39	\$18
Other state schemes	0.15	\$7	0.16	\$7	0.19	\$9	0.20	\$9
<b>Wholesale</b>	<b>10.01</b>	<b>\$460</b>	<b>13.23</b>	<b>\$608</b>	<b>11.28</b>	<b>\$518</b>	<b>8.81</b>	<b>\$405</b>
<b>Regulated networks</b>	<b>13.63</b>	<b>\$627</b>	<b>13.47</b>	<b>\$619</b>	<b>13.57</b>	<b>\$623</b>	<b>13.67</b>	<b>\$628</b>
Transmission	2.48	\$114	2.36	\$108	2.36	\$108	2.39	\$110
Distribution	11.15	\$512	11.11	\$511	11.21	\$515	11.28	\$518
<b>TOTAL</b>	<b>28.16</b>	<b>\$1,294</b>	<b>31.19</b>	<b>\$1,433</b>	<b>29.58</b>	<b>\$1,359</b>	<b>27.45</b>	<b>\$1,261</b>

18 B Phillips, ANU Centre for Social Research, *Research Note: Household Energy Costs in Australia 2006 to 2016*, February 2017.

19 Australian Energy Market Commission, *2017 Residential Electricity Price Trends Final Report*, page viii.

20 J Elton-Pym, SBS News, *Coalition to adopt 49 of 50 Finkel energy suggestions but undecided on clean energy target*, 13 July 2017 <https://www.sbs.com.au/news/coalition-to-adopt-49-of-50-finkel-energy-suggestions-but-undecided-on-clean-energy-target>, (accessed 7 March 2018).



# ENERGY SECURITY

In June 2017, Australia's Chief Scientist Dr Alan Finkel handed down the *Blueprint for the Future*, the final report of the Independent Review into the Future Security of the National Electricity Market.

Known colloquially as the Finkel Review, it was the outcome of an investigation into Australia's energy affordability and reliability that had begun as a result of South Australia's statewide blackout in September 2016.

In the report, Dr Finkel made 50 recommendations – 49 of which were accepted by the Federal Government. The notable exception was the adoption of a Clean Energy Target beyond 2020.

This means there is currently no stable Federal Government energy and carbon strategy or policy past the end of the decade. Debate and policy development continues on the National Energy Guarantee proposed by the Energy Security Board.

Some of the Finkel Review recommendations that were adopted included:

- a plan for more battery storage for renewables similar to the Tesla battery in South Australia
- development of the Snowy 2.0 hydro scheme
- a new requirement that coal-fired power stations provide at least three years' notice before shutting down.<sup>20</sup>

During the summer of 2017-18, coal-fired power stations struggled to keep up with demand, with several tripping and failing as age and heat took their toll.

However, the good news is that renewable energy is stepping up to take the place of this ageing coal-fired infrastructure. When the Loy Yang power station failed in January 2018, the much-touted Tesla battery stepped into action, delivering 100 MW into the national electricity grid in 140 milliseconds.<sup>21</sup>

The Australian Electricity Market Operator (AEMO) has also been focusing on using demand response to deal with extreme peaks of demand in the power system. As part of this, AEMO has joined forces with the Australian Renewable Energy Agency (ARENA) to fund 10 pilot projects under the demand response initiative to manage electricity supply during extreme peaks.

This \$35.7 million initiative will deliver 200 MW of capacity by 2020, with 143 MW to be available for the 2018-19 summer. Over three years, the pilot projects will be trialled in Victoria, South Australia and New South Wales to free up temporary supply during extreme weather – such as prolonged summer heatwaves – and unplanned outages.<sup>22</sup>

Clean energy sources such as cogeneration, trigeneration and solar can help reduce strain on the electricity network during peak demand times. Energy efficiency measures and demand management can also make a big impact in reducing peak demand. The effectiveness of solar was demonstrated by a heatwave in Queensland from 12-16 February 2018, when the rooftop solar installed across the state provided between 400 MW and 585 MW per day to help meet a record thirst for energy.<sup>23</sup>

## CASE STUDY

### LIDDELL POWER PLANT

In a move that sparked extensive political debate, AGL announced plans to replace the Liddell coal-fired power plant in the Hunter Valley with a clean energy hub consisting of renewable energy, gas, batteries, smart technology and demand management.

This decision came as the Turnbull Government put pressure on AGL to extend the life of a plant that started operating in the early 1970s and is mooted for closure in 2022.

The \$1.36 billion project will include new gas, wind and solar plants, along with a coal plant upgrade and a large battery. According to AGL, the electricity generated by the hub will cost 20 per cent less to produce than extending Liddell's life by five years. It will also cut AGL's carbon emissions by almost 18 per cent and allow for 'dispatchable' clean energy during times of peak demand.

Energy Minister Josh Frydenberg initially questioned how the plan would address the 1000 MW shortfall in baseload power on the east coast caused by the closure of Liddell. According to the Australian Energy Market Operator, the clean energy hub will adequately replace the coal plant, as long as AGL follows through with all the investments it has in the pipeline.<sup>24</sup>

AGL has argued that its planned renewable hub can do everything a coal plant can do, but cleaner and more reliably.

21 AAP, news.com.au, *That's a record: South Australia's Tesla battery responds to coal-fired plant failure*, 21 December 2017 <http://www.news.com.au/technology/environment/thats-a-record-south-australias-tesla-battery-responds-to-coalfired-plant-failure/news-story/d9e02c0dbf6774ffea948a1b919f3b7f> (accessed 14 February 2018).

22 ARENA/AEMO joint media release, *AEMO and ARENA demand response trial to provide 200 megawatts of emergency reserves for extreme peaks*, 11 October 2018.

23 G Parkinson, Renew Economy, *AEMO points to rooftop solar's critical role in "remarkable" heat event*, 1 March 2018 <https://reneweconomy.com.au/aemo-points-to-rooftop-solars-critical-role-in-remarkable-heat-event-70187/> (accessed 11 April 2018).

24 A Zibelman, AEMO, *Advice to the Commonwealth relating to AGL's proposal to replace Liddell*, 16 March 2018, p 8.

# ENERGY STORAGE

The big news in energy storage in 2017 was the construction and commissioning of the world's biggest lithium-ion battery in South Australia, installed by Tesla and owned by Neoen.

Located 15 km north of Jamestown and covering about a hectare of land, the Hornsdale Power Reserve stores power from the Hornsdale Wind Farm, which will be the largest renewable generator in the state once construction is complete. The facility was funded by the South Australian Government.

On the back of this installation, Tesla reported a surge in sales of its commercial energy storage products and has won a number of other contracts, including the 20 MW/34 MWh battery that will be linked to the 196 MW Bulgana Wind Farm and will provide Australia's biggest greenhouse with 100 per cent renewable energy.<sup>25</sup> Other projects are being planned across the country.

Tesla has also reported an increase in home storage systems, and SunWiz's Battery Market Report backs up this claim, stating that 20,789 energy storage systems were installed in 2017, a three-fold increase on the 6750 installed in 2016.

SunWiz reports that 12 per cent of the 172,000 PV installations in 2017 included a battery, up from 5 per cent in 2016. This brings the cumulative tally to 28,000 battery systems installed across Australia.<sup>26</sup>

On a state-by-state basis, SunWiz estimates that 42 per cent of the nation's total storage installations have occurred in New South Wales, with 19 per cent located in Queensland, 17 per cent in Victoria and 11 per cent in SA.

SunWiz reports that the return on investment (ROI) for solar panels plus battery storage is still not as high as the ROI for panels alone. The Battery Market Report shows that a battery doesn't pay for itself as quickly as a 5 kW panel-only system, which has a typical ROI of 22.9 per cent and will pay for itself in five years. In contrast, the ROI on a battery is closer to 11 per cent (about a nine-year payback). According to SunWiz, ROI is highest in South Australia and is lowest in the ACT.<sup>27</sup>

According to energy economist Bruce Mountain, the annual cost of solar plus storage in South Australia is now cheaper than buying power from the grid.<sup>28</sup>

Virtual power plants and other battery storage initiatives by various state governments are helping to drive demand at the consumer level, improving ROI on battery unit prices as costs fall.

During the recent South Australian election, energy cost and reliability

were high on the agenda for both major parties as well as Nick Xenophon's SA Best Party. German battery maker Sonnen announced that it will transfer its operations to Adelaide, showing the complementary nature of renewable energy and battery technology.<sup>29</sup>

Another major energy storage project is the mooted Snowy 2.0 pumped hydro expansion, one of several pumped hydro projects planned in the foreseeable future.

A number of companies are also either exploring or actively planning to build new pumped hydro facilities, including Genex Power's project at Kidston near Townsville in North Queensland and Tilt Renewables' pumped hydro plant project at a decommissioned quarry north of Adelaide.

As far as the forecast for 2018, SunWiz predicts 300 MWh of distributed systems will be built across 33,000 installations, along with 136 MWh of projects. This would more than double the number of storage systems currently installed.

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25 S Vorrath and G Parkinson, Renew Economy, *Musk says storage orders surge on success of Tesla big battery*, 8 February 2018 <http://reneweconomy.com.au/musk-says-storage-orders-surge-on-success-of-tesla-big-battery-63587/> (accessed 7 March 2018).

26 SunWiz, *2018 Battery Market Report*, March 2018.

27 Ibid.

28 B Mountain, Renew Economy, *Tesla battery + solar now "significantly cheaper" than grid power*, 20 February 2018 <http://reneweconomy.com.au/tesla-battery-solar-now-significantly-cheaper-grid-power-51011/> (accessed 8 March 2018).

29 S Evans, The Australian Financial Review, *Germany's Sonnen to set up storage battery plant in SA*, 22 February 2018.

## RESIDENTIAL ENERGY STORAGE SYSTEM INSTALLATIONS<sup>30</sup>

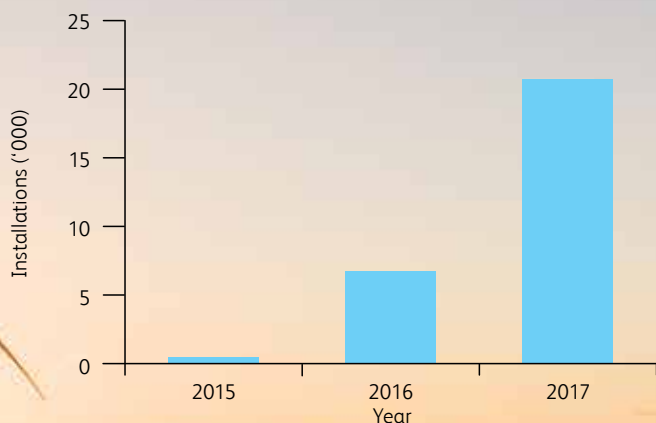


Image: Hornsdale Power Reserve, South Australia

<sup>30</sup> SunWiz, 2018 Battery Market Report, March 2018.

<sup>31</sup> AAP, news.com.au, *That's a record: South Australia's Tesla battery responds to coal-fired plant failure*, 21 December 2017, <http://www.news.com.au/technology/environment/thats-a-record-south-australias-tesla-battery-responds-to-coalfired-plant-failure/news-story/d9e02c0dbf6774ffea948a1b919f3b7f> (accessed 14 February 2018).

## CASE STUDY HORNSDALE POWER RESERVE/TESLA BIG BATTERY IN SA

It started as a Twitter conversation between tech billionaires Elon Musk and Mike Cannon-Brookes, with the latter challenging the Tesla boss to end South Australia's power problems following the state-wide blackout in September 2016.

Musk responded that he would build a 100 MW battery in 100 days from signing the contract, or it would be free.

Tesla easily beat the deadline, and on the first day of summer 2017 it was officially switched on.

The lithium-ion battery sits alongside the Hornsdale Wind Farm and has been constructed in partnership with the SA Government and Neoen, the French company that owns the wind farm.

The battery has a total generation capacity of 100 MW and 129 MWh of energy storage. This is reportedly capable of powering more than 30,000 homes, but it's much more than just a big Duracell. The Hornsdale Power Reserve can also provide a range of services to help stabilise the energy system – and at a lightning-fast speed.

It is charged using renewable energy from the wind farm and then delivers electricity during peak hours to help maintain the reliable operation of South Australia's electrical infrastructure.

Shortly after its official commissioning, the Tesla battery showed its worth, responding quickly when the coal-fired Loy Yang power plant tripped and went offline, delivering 100 MW into the national electricity grid in 140 milliseconds.<sup>31</sup>



Bioenergy is renewable energy generated from some form of biomass fuel to produce electricity. Some plants produce both electricity and heat, and this is known as cogeneration.

About 10 per cent of Australia’s clean energy was produced by bioenergy power plants in 2017. Liquid fuels developed for transport such as freight and aviation are not covered by the scope of this report.

Bioenergy fuel sources are often derived from agricultural, forestry and municipal wastes. Sugar cane waste – known as bagasse – remains the most common form of bioenergy generation, closely followed by landfill gas. Other common sources include the black liquor derived from paper making, as well as sewage gas and food waste.

According to the Federal Government’s Australian Energy Statistics, Queensland produced the most bioenergy of any state in 2016-17, primarily due to the large number of bagasse cogeneration plants associated with the sugar industry in the northern and central coastal regions. It was followed by New

South Wales, Victoria and Western Australia, with bioenergy power plants in other states generating relatively negligible amounts of renewable energy certificates.

The largest project completed during 2017 was the Worsley Multi-Fuel Cogeneration Plant, which will supply electricity and heat for alumina refining at Collie, 189 km south-east of Perth.

The Northern Adelaide Waste Management Authority completed a 2.4 MW combined solar and methane plant in 2017. The two fuel sources use a shared turbine interconnector to feed electricity back into the South Australian grid. Combining solar and landfill gas is understood to be an Australian first.

MSF Sugar’s \$75 million Green Energy Power Plant at its Tableland Mill was one of the few major new bioenergy projects at an advanced stage of development

during 2017. Construction on the 24 MW plant started in May 2017, and the plant will use bagasse from local sugar operations to produce power when it is completed in mid-2018.<sup>32</sup> The company is also trialling blue agave, the plant used to make tequila, to determine the feasibility of the crop for the region and its potential use in the green energy power plant.<sup>33</sup>

Construction on a \$400 million waste-to-energy power plant at Kwinana in Western Australia is scheduled to begin in earnest in the second quarter of 2018. The 40 MW project is being led by Phoenix Energy and co-sponsored by Macquarie Capital. Spanish infrastructure and renewable energy company ACCIONA and waste management company Veolia are also involved. Phoenix Energy estimates the project will deliver power to Perth within a few years.<sup>34</sup>

## 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 II	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 Ltd	Racecourse	2013	38

<sup>32</sup> A Davy, *The Weekly Times*, *MSF Sugar’s Tableland Mill to produce electricity and ethanol*, 2 November 2017.

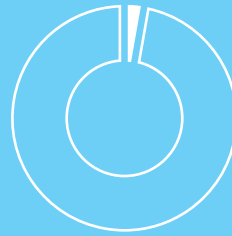
<sup>33</sup> MSF Sugar, *Tableland Green Energy Power Plant*, <https://www.msfsugar.com.au/our-mills/tableland-mill/tableland-green-energy-power-plant>, (accessed 6 April 2018).

<sup>34</sup> A Boyham, *Sound-Southern Telegraph*, *Waste-to-energy facility on way*, 9 January 2018.

<sup>35</sup> Department of the Environment and Energy, *Australian Energy Update 2017*, Table O, Australian Government, September 2017.



**9.7%**  
of total clean  
energy generated in  
Australia in 2017

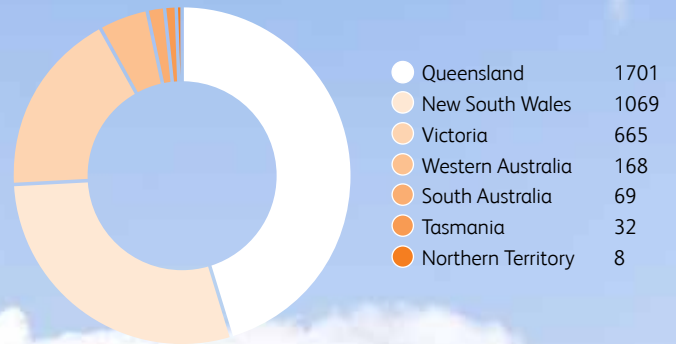


**1.7%**  
of total Australian  
electricity generated  
in 2017

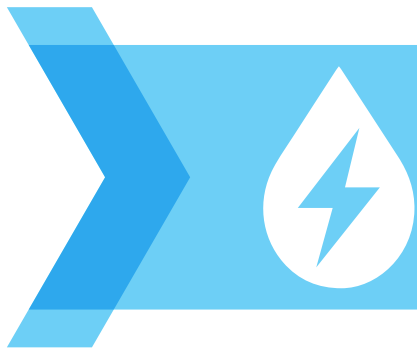
### BIOENERGY PROJECTS COMPLETED IN 2017

PROJECT	STATE	INSTALLED CAPACITY (MW)	FUEL SOURCE
Worsley Multi-Fuel Cogeneration Plant	WA	114	Biomass
NAWMA	SA	2.4	Solar, Biomass
Tong Park	QLD	1.2	Biomass
Rewaste Wollert	VIC	1.1	Biomass

### STATIONARY BIOENERGY PRODUCTION BY STATE, 2016-17 (GWh)<sup>35</sup>



# HYDRO



Hydro power has traditionally been Australia’s leading form of renewable energy. There are more than 120 working hydro power stations in Australia, with most of the nation’s hydroelectricity generated by Hydro Tasmania’s network of power plants and the Snowy Mountains Hydro Scheme in New South Wales.

**22,000**  
number of potential pumped hydro sites across Australia

**2500**  
potential pumped hydro potential, in megawatts, in Tasmania

Overall hydro output was down in 2017 compared to the previous year. According to Hydro Tasmania, the lower generation was principally due to below average rainfall in catchment areas compared with the year before.

With the support of the Australian Renewable Energy Agency, the Australian National University (ANU) has identified 22,000 potential pumped hydro sites across Australia. The largest number of these were in New South Wales and Victoria. So many good quality pumped hydro sites were identified that the ANU says that only the top 0.1 per cent of these would be needed to provide the necessary support for a 100 per cent renewable energy system in Australia.<sup>36</sup>

In collaboration with the Federal Government, the Tasmanian Government’s ‘Battery of the Nation’ initiative is investigating and developing pathways of future development opportunities that would allow Tasmania to make a greater contribution to the National Electricity Market. Initial studies have identified significant pumped hydro potential in the state, potentially delivering up to 2500 MW of energy – nearly doubling Hydro Tasmania’s current capacity.<sup>37</sup>

The Snowy 2.0 expansion and the Battery of the Nation proposal clearly show there is significant interest in expanding the nation’s hydro resources to provide additional storage capacity to complement renewable energy such as wind and solar power.

## HYDRO POWER’S CONTRIBUTION TO AUSTRALIAN ELECTRICITY GENERATION<sup>38</sup>

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	12,920	33.9%	5.7%

<sup>36</sup> Professor A Blakers, Australian National University, ARENA WIRE, *There are 22,000 possible sites for pumped hydro storage across Australia*, 19 September 2017 <https://arena.gov.au/blog/andrew-blakers/> (accessed 11 April 2018).

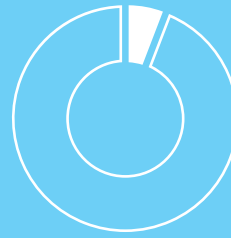
<sup>37</sup> Hydro Tasmania, *Battery of the Nation FAQs*, <https://www.hydro.com.au/clean-energy/battery-of-the-nation/battery-of-the-nation-FAQs> (accessed 8 March 2018).

<sup>38</sup> NEM Watch.





**33.9%**  
of total clean  
energy generated in  
Australia in 2017



**5.7%**  
of total Australian  
electricity generated  
in 2017

## CASE STUDY SNOWY 2.0

In March 2017, Snowy Hydro announced plans to carry out a feasibility study into a pumped hydro expansion of the Snowy Hydro Scheme.

The original project took a quarter of a century to build – from 1949 to 1974 – and employed thousands of refugees from war-torn Europe in search of a new life.

The feasibility study showed that Snowy 2.0 is both technically and financially viable, and Snowy Hydro's independent Board of Directors has given its stamp of approval to progress

to a decision on final investment and to undertake further work refining the project.

When complete, Snowy 2.0 will increase the Snowy Hydro Scheme's generation capacity by up to 2000 MW. At full capacity, it will provide approximately 350,000 MWh of energy storage.

Instead of releasing water once the energy has been generated, the pumped hydro expansion would pump water back to the upper reservoir to be used again.

As the country transitions from coal-fired power to more renewable energy sources, there is a clear role for Snowy 2.0 to provide reliable, stable and affordable electricity long into the future. Snowy 2.0 is a perfect complement to help smooth out the supply of wind and solar power for use when it is most needed.

Not only could the proposal to expand the Snowy Hydro Scheme be a game-changer for renewable energy in Australia, it could, like its predecessor, provide local employment opportunities for years to come.



Image: Gordon Hydroelectric Power Station, Tasmania



While there is no doubt that marine energy has the potential to be a leading source of renewable power generation, it is still an under-utilised resource. Several research projects aim to harness the power of the tides.

The Australian Wave Energy Atlas, an initiative of CSIRO, delivered a searchable, free and publicly available online web atlas of Australia's national wave energy resource and marine management uses in 2018. It also provided best practice guidelines on physical impact assessments for wave energy developments in Australia's marine domain.<sup>39</sup>

Similarly, Tidal Energy in Australia, a joint research project of CSIRO, the Australian Maritime College at the University of Tasmania, the University of Queensland and industry

partners will develop a hydrodynamic tidal model to map the scale and distribution of the nation's tidal energy resources to the nearest 500 m.<sup>40</sup>

In other marine developments, Sydney company Wave Swell Energy has created a prototype to harness the power of waves, effectively acting as an artificial blowhole. The company will build a \$7 million large-scale unit on the seabed near the coast of King Island that will feed into Hydro Tasmania's grid, and at peak times will provide up to half the island's power.<sup>41</sup>

39 ARENA, *The Australian Wave Energy Atlas*, <https://arena.gov.au/projects/australian-wave-energy-atlas/> (accessed 8 March 2018).

40 ARENA, *Unlocking the potential of Australia's tidal energy*, media release, 13 July 2017.

41 E Stewart, ABC Online, *Sydney runner Dr Tom Denniss to harness waves to provide Tasmanians with electricity*, 4 May 2017 <http://www.abc.net.au/news/2017-05-03/sydney-runner-uses-waves-to-bring-electricity-to-tasmania/8494516> (accessed 8 March 2018).







Image: MAKO tidal turbine, Tamar River Project, Tasmania



2017 was a record year for rooftop solar. The average system size continued to grow as more commercial-sized systems were installed for small and medium-sized businesses. While this meant fewer systems installed overall, the total capacity installed (more than 1.1 GW) was an Australian record for a calendar year.

1.1

gigawatts of solar capacity installed across Australia

Some states experienced installation bottlenecks as intense competition for resources sent businesses scrambling to secure qualified staff.

This creates major opportunities for electricians to skill up and take on more work in the solar sector.

There are now slightly more installers accredited with the Clean Energy Council than there were in 2012, the previous highest year for Australian solar. In 2017, the number of new accredited installers per month increased by 60 per cent compared to 2016.

Eight out of the top 10 solar postcodes were in Queensland, continuing a trend of several years.

### CASE STUDY CLIMATE-FRIENDLY STUDENT DIGS



Image: Battery installation at Stucco Housing Co-operative, New South Wales

Low-income students at the heritage-listed Stucco Housing Co-operative in Newtown, Sydney are enjoying the tangible experience of lower power bills through living with renewable energy thanks to Stuart Bruce and Dean Edmonds.

The dynamic installer duo, working with Solaray Energy, were worthy winners of a Clean Energy Council Solar Design and Installation Award in 2017 in the Under 30 kW – grid connect with battery back-up category.

The project also involved creating and signing a landmark power purchase agreement between Stucco and the tenants, which will help break down barriers that have made it difficult to develop solar and storage systems in apartments.

The state-of-the-art solar storage system features 36 modular Enphase batteries with a capacity of 42.3 kWh, along with a 30 kW solar array, cloud-based monitoring with module-level

insights and full back-to-base support capabilities.

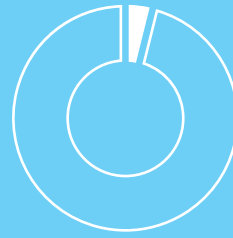
The array is split across two roof sections, with the panels installed in line with the roof to minimise obstruction of the view. The low tilt angle also ensures maximum output of solar power across the day during the summer months.

In its first 165 days of operation, the solar and storage system allowed Stucco to be 76 per cent independent from the grid. The project is also carbon negative, producing 128 per cent of the energy required by the building thanks to the battery storage providing much-needed energy in the evenings when students return from their classes.

The solar and storage system provides renewable electricity to the 40 residents currently living at Stucco and is expected to benefit about 1000 low-income students over its lifetime. It marks an Australian-first example of urban sustainability, energy autonomy and community leadership.

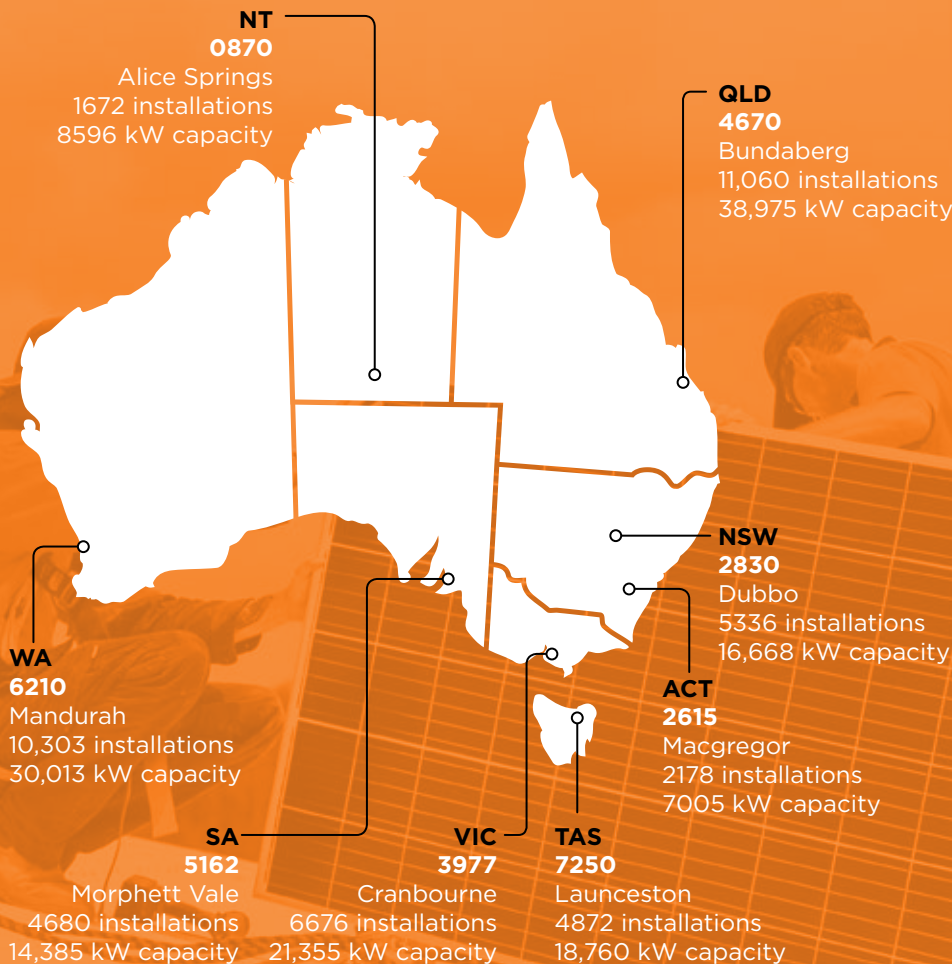


**20.3%**  
of total clean  
energy generated in  
Australia in 2017



**3.4%**  
of total Australian  
electricity generated  
in 2017

### TOP SOLAR POSTCODE IN EACH STATE<sup>42</sup>



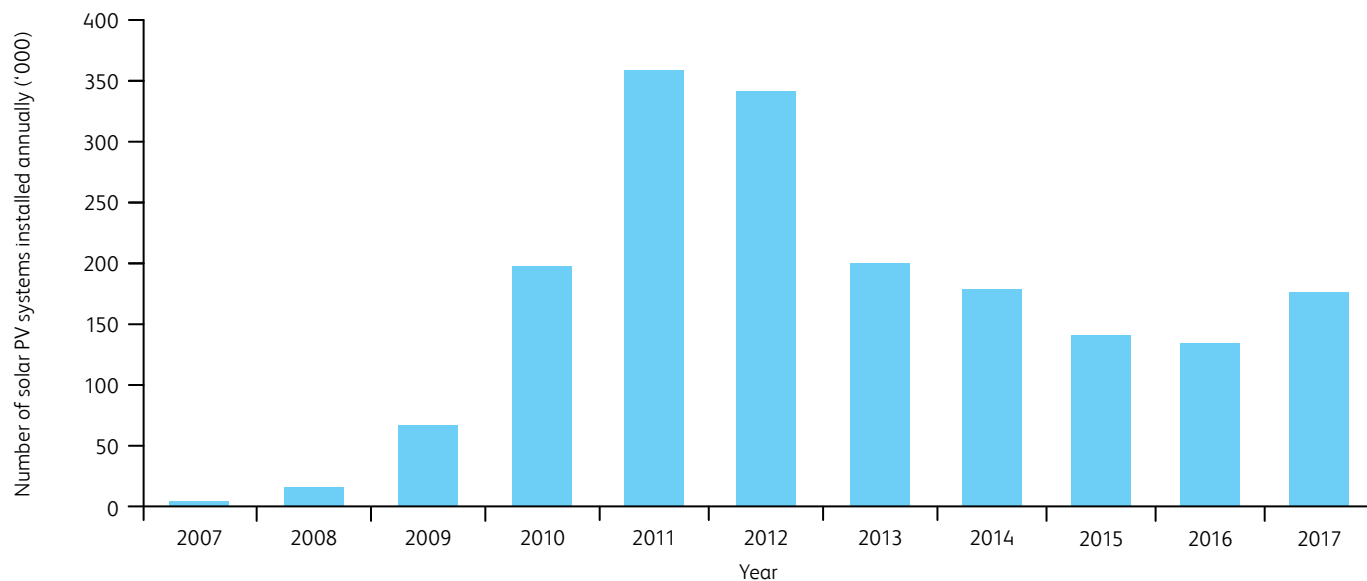
### TOP TEN SOLAR POSTCODES IN AUSTRALIA - BY CAPACITY<sup>42</sup>

- BUNDABERG QLD 4670**  
11,060 installations  
38,975 kW capacity
- HERVEY BAY QLD 4655**  
9673 installations  
31,637 kW capacity
- MANDURAH WA 6210**  
10,303 installations  
30,013 kW capacity
- MACKAY QLD 4740**  
6850 installations  
29,778 kW capacity
- WANGARA AND WANNEROO WA 6065**  
7822 installations  
28,526 kW capacity
- TOOWOOMBA QLD 4350**  
7915 installations  
28,319 kW capacity
- NERANG AND CARRARA QLD 4211**  
7332 installations  
26,867 kW capacity
- CALOUNDRA QLD 4551**  
8612 installations  
26,147 kW capacity
- BEENLEIGH QLD 4207**  
6594 installations  
23,869 kW capacity
- CAIRNS QLD 4870**  
5034 installations  
23,206 kW capacity

42 Clean Energy Regulator.

Image: Commercial solar installation, New South Wales

## ANNUAL SOLAR PV INSTALLATIONS<sup>43</sup>

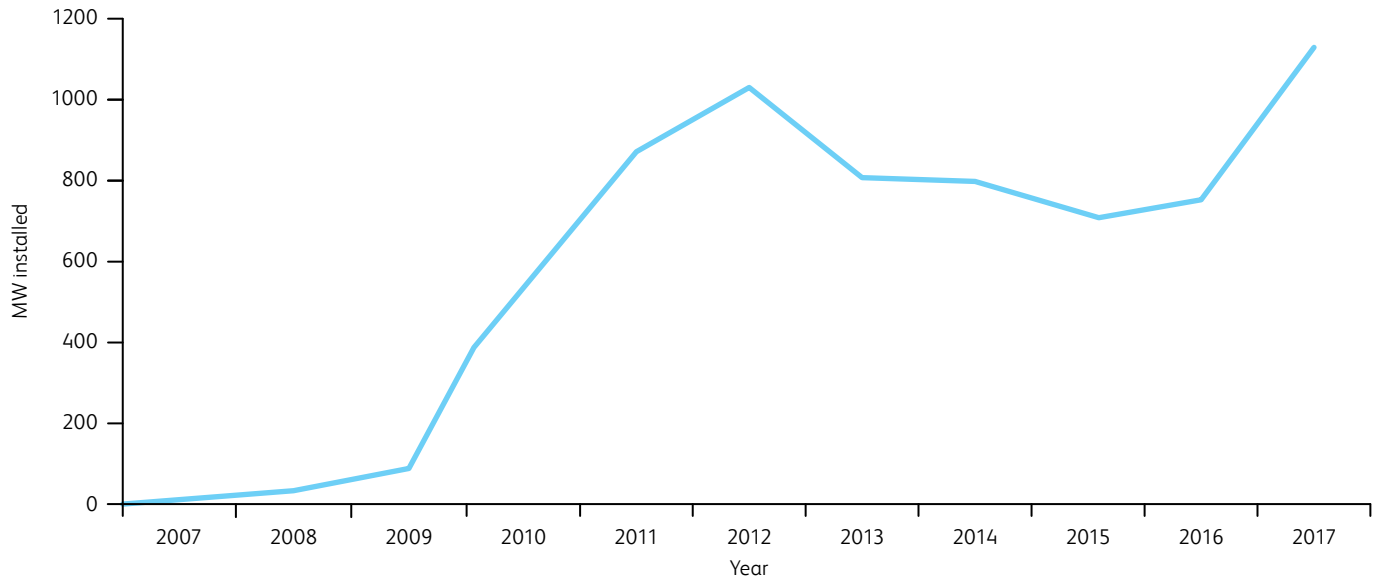


INSTALLATION YEAR	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	NATIONAL
2007	102	779	26	475	1037	26	828	262	3535
2008	278	2,890	88	3,087	3,456	161	2,036	2,068	14,064
2009	803	14,008	215	18,283	8,569	1,452	11,847	11,157	66,334
2010	2,323	69,988	637	48,697	16,705	1,889	35,676	22,293	198,208
2011	6,860	80,272	401	95,303	63,553	2,475	60,214	51,667	360,745
2012	1,522	53,961	513	130,252	41,851	6,364	66,204	42,653	343,320
2013	2,411	33,998	1,024	71,197	29,187	7,658	33,332	21,600	200,407
2014	1,225	37,210	1,026	57,748	15,166	4,207	40,061	23,496	180,139
2015	1,066	33,477	1,197	39,507	12,081	2,020	31,343	20,797	141,488
2016	1,001	29,572	1,745	34,426	12,605	2,487	26,749	24,200	132,785
2017	1,748	44,217	1,977	48,941	16,117	2,480	30,477	33,500	179,457
TOTAL*	19,369	401,424	8,953	549,034	221,983	31,269	339,680	253,929	1,825,641

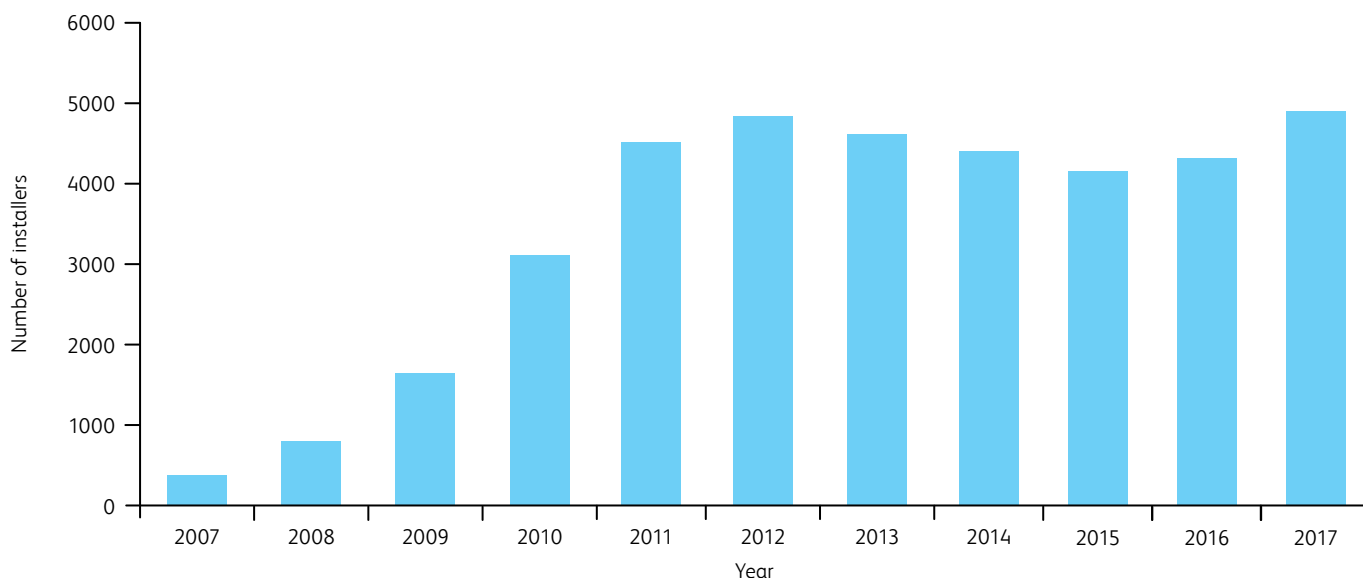
\*Total includes pre-2007 installations

<sup>43</sup> Clean Energy Regulator, Solar Homes and Communities Plan, SunWiz.

## ANNUAL INSTALLED CAPACITY OF SOLAR PV (MW)<sup>44</sup>

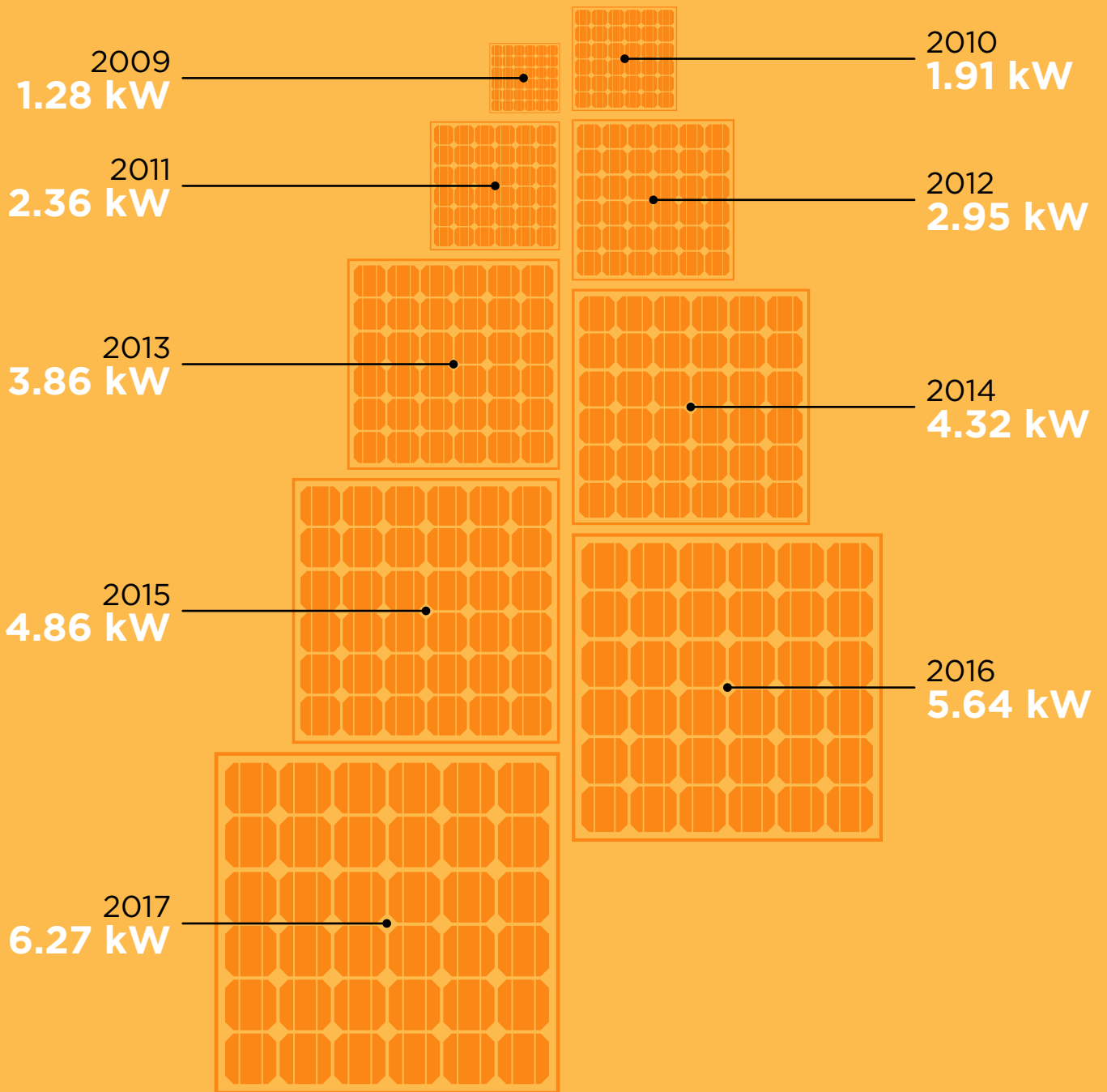


\*Total includes pre-2007 installations

**TOTAL NUMBER OF ACCREDITED INSTALLERS AND DESIGNERS**

YEAR	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	TOTAL
2007	6	95	13	73	25	14	66	46	338
2008	11	192	11	143	57	24	245	95	778
2009	28	360	16	349	130	43	473	220	1619
2010	46	879	16	675	252	45	754	414	3081
2011	53	1034	22	1187	593	71	1004	531	4495
2012	48	948	28	1391	650	120	1122	514	4821
2013	44	894	41	1336	604	144	1093	439	4595
2014	44	908	47	1263	521	137	1075	401	4396
2015	44	916	51	1151	490	109	998	384	4143
2016	56	951	70	1188	500	101	974	465	4305
2017	66	1085	72	1354	552	112	1059	612	4912

NATIONAL AVERAGE SYSTEM SIZE (KW)<sup>45</sup>



<sup>45</sup> Clean Energy Regulator.



In 2017, 131 medium-scale solar projects were commissioned, adding 53 MW of new capacity. This represents a significant increase compared to 2016, when 23 MW of capacity was added across 68 projects.



167

megawatts of capacity in the medium-scale sector

500%

increase in capacity since 2012

\$3.2M

invested in medium-scale solar by egg producer Pace Farms



Image: Solar carpark shading system at the University of Southern Queensland

There is now 167 MW of cumulative capacity in the medium-scale solar sector, representing an increase of more than 500 per cent over the past five years. This rapid growth has been driven by a significant rise in electricity prices, which has forced an increasing number of businesses to look to solar power to offset their rising costs.

While the commercial sector has been the biggest driver of the growth in this segment, organisations such as universities, schools and government bodies have also recognised the considerable savings that can be

made by making better use of their rooftop space.

Notable new projects commissioned in 2017 include Australia Post's 2.1 MW rooftop solar system at its Chullora sorting centre in Sydney, the largest single-roof solar system in Australia, and the installation of a 1.8 MW rooftop solar system at Charles Sturt University's Wagga Wagga campus.

The agricultural sector has also been a major player in this segment, with egg farmers leading the way. The Australian egg

industry installed a number of medium-scale solar projects in 2017 with a combined capacity of 7 MW.

Leading egg producer Pace Farms invested \$3.2 million in three separate solar projects across its New South Wales operations in 2017 in an effort to reduce the electricity costs associated with cooling the sheds that house its chickens.

Other agricultural businesses that turned to solar to reduce their energy costs in 2017 included wineries, abattoirs and vegetable growers.





**0.5%**  
of total clean  
energy generated in  
Australia in 2017



**0.1%**  
of total Australian  
electricity generated  
in 2017



### CASE STUDY LISMORE'S FLOATING SOLAR FARM

It may sound like the opening line of a joke: “Did you hear the one about the solar panels and the sewage treatment ponds?”, but Lismore’s new floating solar farm also happens to be the largest such facility in the country.

The 100 kW farm, opened early in 2018, floats on the surface of an overflow pond at the East Lismore Sewage Treatment Plant, and the electricity it generates is being used to partially power the plant.

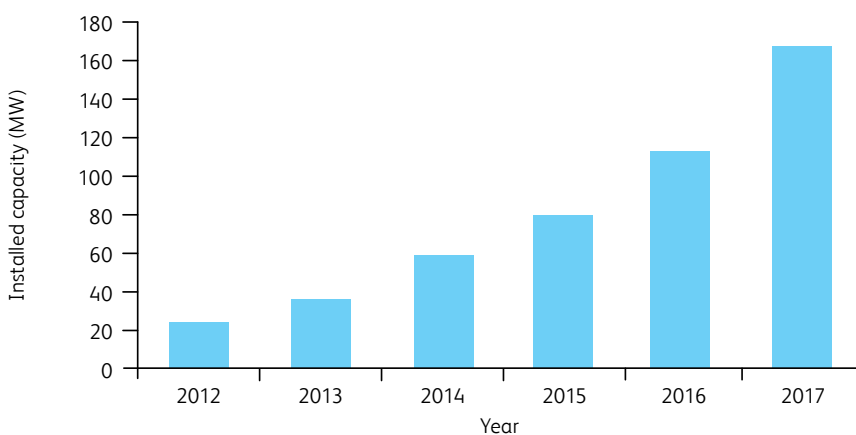
It has the capacity to generate approximately 180,000 kWh of electricity each year – enough for about 12 per cent of the treatment plant’s consumption.

This can potentially be expanded up to five times its current size and can also accommodate the installation of battery storage. The Lismore City Council plans to source electricity from renewable energy for the whole plant in the future.

The cooling effect of the water means the panels will last longer and perform better, and the array has been designed to withstand flooding.

Not only will the farm save on Lismore City Council’s electricity bills, it will go a long way to meeting the council’s Renewable Energy Master Plan to achieve the goal of self-generating all its electricity from renewable sources by 2023.

### CUMULATIVE INSTALLED CAPACITY (MW)<sup>46</sup>



46 Clean Energy Regulator.



Four new large-scale solar projects were completed in 2017, with the largest being the 50 MW plant built by Genex at Kidston in North Queensland. Total installed large-scale solar capacity reached 450 MW at the end of 2017, which is a remarkable result considering that just 34 MW was installed at the end of 2014.

21

large-scale solar projects under construction at the end of 2017

82,000

households will be powered by the Bungala Solar Farm in Port Augusta, SA

US\$50

average global cost of solar PV per megawatt-hour



Image: Kidston Solar Project, Queensland

Twenty-one large-scale solar projects were under construction at the end of 2017. The largest of these is the 220 MW Bungala Solar Farm, which is located near Port Augusta in South Australia. Once completed, it will be Australia's largest solar farm, generating enough electricity to power 82,000 Australian households.

A number of other large solar farms are also nearing completion, including the 148 MW Ross River and 116 MW Sun Metals Solar Farms in Queensland, and the 100

MW Clare Solar Farm in New South Wales.

While Australia's largest current solar plants are in New South Wales, more than half of the projects now under construction are located in Queensland, with large-scale solar hubs in the Darling Downs and Townsville.

The average global cost of solar PV has fallen from \$US178/MWh to just \$US50/MWh over the past eight years,<sup>47</sup> making large-scale solar an increasingly attractive

option for new generation. This has been supplemented by support from the Australian Renewable Energy Agency and the Clean Energy Finance Corporation, which has helped to accelerate cost reductions in the Australian market by providing the seed capital to bring the industry up to scale.

Large-scale solar thermal technology is still in its infancy in Australia, with two plants currently operating in Queensland and New South Wales. However, construction on a 150 MW concentrated solar

<sup>47</sup> G Parkinson, Renew Economy, *Wind, solar costs continue fall, and fossil fuels can't stop them*, 8 November 2017 <http://reneweconomy.com.au/wind-solar-costs-continue-fall-and-fossil-fuels-cant-stop-them-82305/> (accessed 11 April 2018).



**1.8%**  
of total clean  
energy generated in  
Australia in 2017



**0.3%**  
of total Australian  
electricity generated  
in 2017



thermal plant is scheduled to begin in South Australia in 2018, which will give the segment a considerable boost.

The Aurora Solar Energy Project will use heliostats to concentrate sunlight onto a tower that heats molten salt, which is then used to create steam to run turbines that generate electricity. The project, which will be the largest of its kind in the world upon completion, will store energy for up to 10 hours and has the distinct advantage of being able to provide dispatchable power at night or on days with low wind.

### LARGE-SCALE SOLAR PLANTS COMMISSIONED IN 2017<sup>48</sup>

TECHNOLOGY	PROJECT	OWNER	STATE	INSTALLED CAPACITY (MW)
Solar PV	Kidston	Genex	QLD	50
Solar PV	Sunshine Coast Solar Farm	Sunshine Coast Regional Council	QLD	15
Solar PV	Lakeland Solar and Storage	Conergy	QLD	13
Solar PV	Gullen Range Solar Farm	Goldwind Australia/BJC	NSW	10

48 SunWiz, AEMO, REC Registry.

## TOP FIVE PLANTS BY SIZE<sup>49</sup>

NYNGAN,  
NSW

Owner: AGL  
Commissioned:  
2015

**102 MW**

MOREE,  
NSW

Owner: FRV  
Commissioned:  
2016

**56 MW**

BROKEN HILL,  
NSW

Owner: AGL  
Commissioned:  
2015

**53 MW**

KIDSTON,  
QLD

Owner: Genex  
Commissioned:  
2017

**50 MW**

BARCALDINE,  
QLD

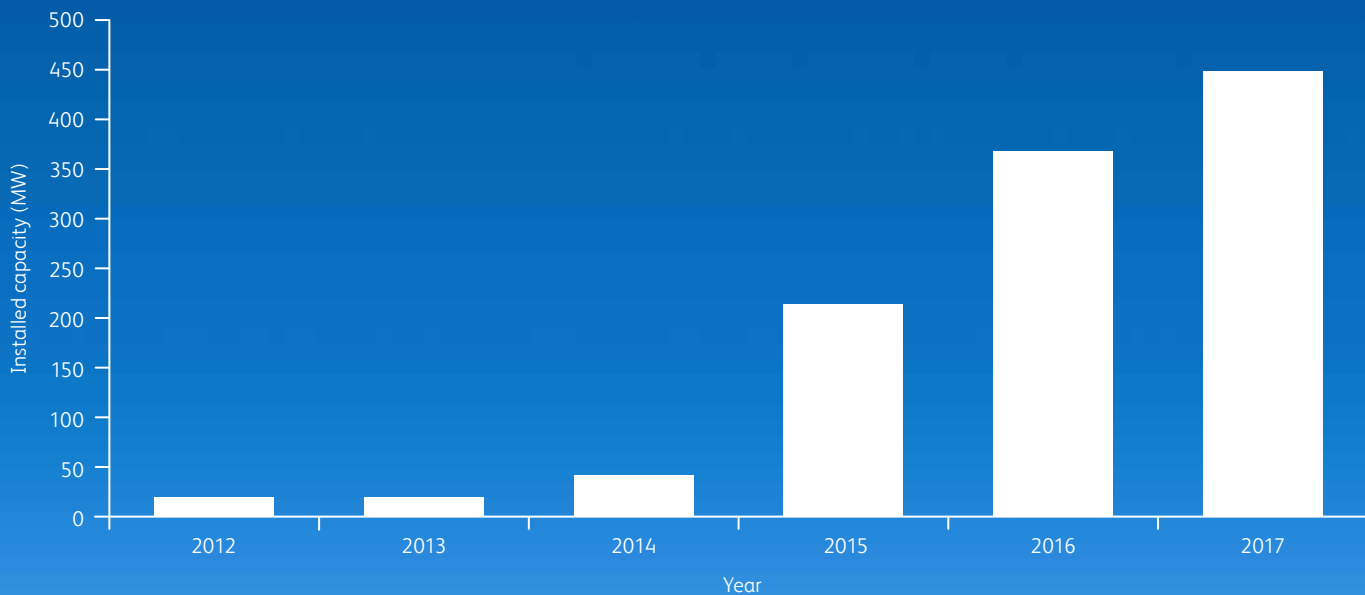
Owner: Elecnor  
Commissioned:  
2016

**25 MW**



<sup>49</sup> SunWiz, AEMO.

## CUMULATIVE INSTALLED CAPACITY (MW)<sup>50</sup>



YEAR	2012	2013	2014	2015	2016	2017
CUMULATIVE INSTALLED CAPACITY (MW)	10.0	10.0	34.0	302.2	361.6	449.6



# SOLAR WATER HEATING



Solar water heating can refer to either a solar hot water system that heats water using energy from the sun or a heat pump that heats water using energy from the air.

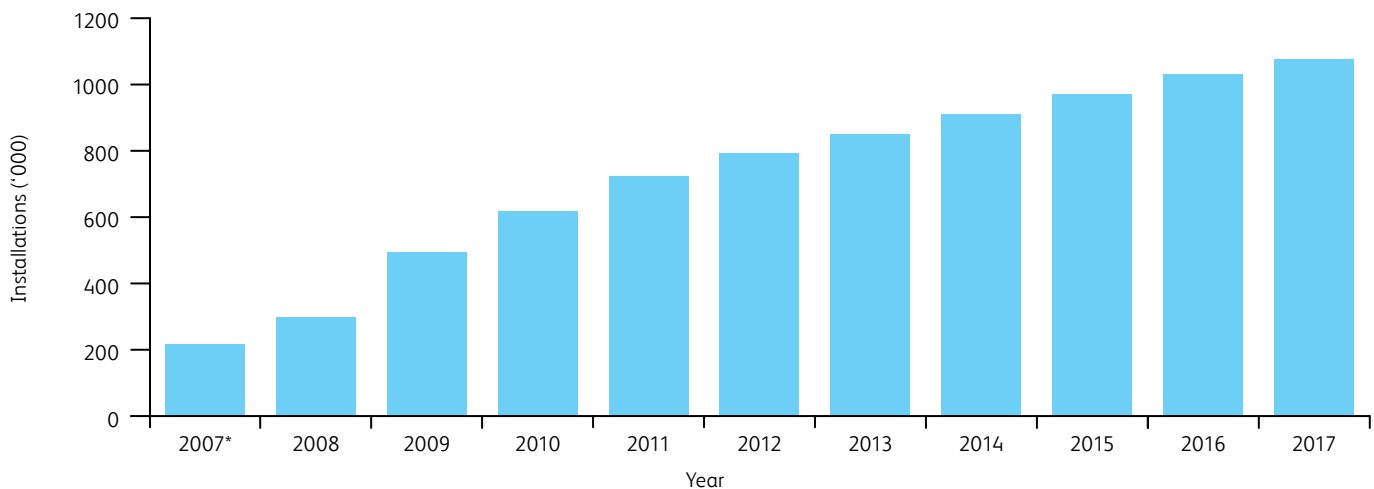
The trend of declining solar water heating installations continued in 2017, with the number of systems installed falling by more than 25 per cent compared to 2016. However, with almost 1.1 million units now having been installed in Australia since 2001, the technology continues to make a very real contribution to the reduction of electricity bills and carbon emissions.

The solar water heating market peaked in 2009, when the Federal Government's \$1600 rebate for the installation of a system resulted in almost 200,000 systems being installed. Installations have fallen considerably since then, with 45,336 units installed in 2017.

In 2017, Victoria overtook both New South Wales and Queensland to

become the state with the highest number of total solar water heater installations. Installation numbers have remained relatively steady in Victoria since 2009, but have dropped off significantly in New South Wales and Queensland. In New South Wales, installations have fallen from over 85,000 in 2009 to just 6000 in 2017.

## CUMULATIVE SOLAR WATER HEATER INSTALLATIONS IN AUSTRALIA

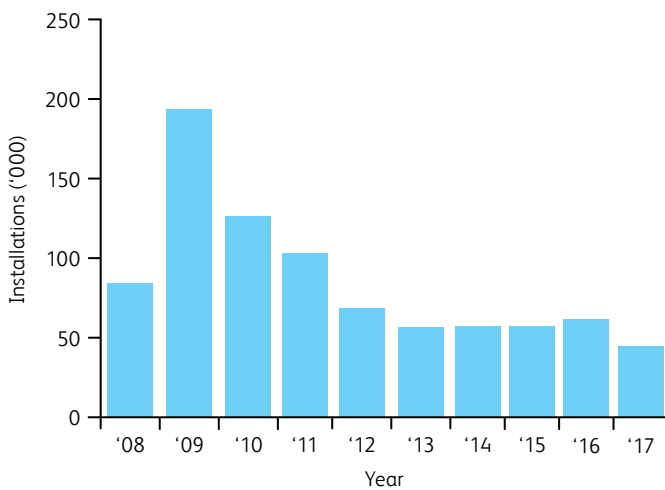


## CUMULATIVE SOLAR WATER HEATER INSTALLATIONS IN AUSTRALIA

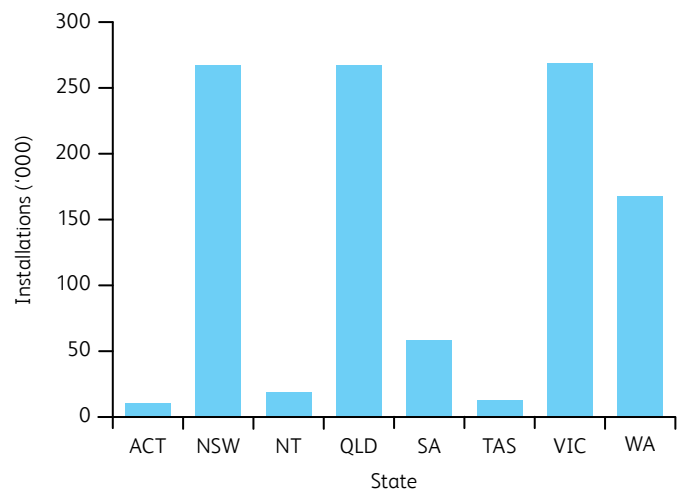
YEAR	2007*	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CUMULATIVE INSTALLATIONS	212,423	297,808	492,503	619,596	724,646	794,112	852,411	911,139	969,843	1,031,743	1,077,079

\*includes pre-2007 totals

## ANNUAL INSTALLATIONS OF SOLAR WATER HEATERS<sup>51</sup>



## TOTAL INSTALLED SOLAR HOT WATER HEATERS BY STATE

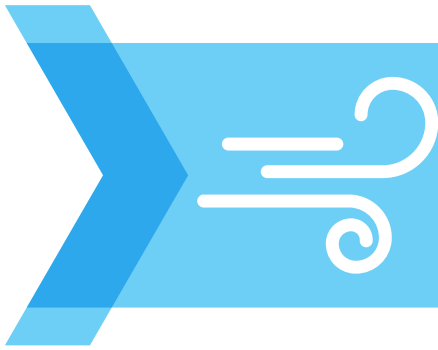


## ANNUAL INSTALLATIONS OF SOLAR WATER HEATERS<sup>51</sup>

INSTALLATION YEAR	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	NATIONAL
2008	1,001	20,203	1,236	23,330	5,103	906	21,208	12,398	<b>85,385</b>
2009	1,974	85,456	1,731	36,659	8,794	2,269	42,120	15,692	<b>194,695</b>
2010	960	38,525	1,303	34,262	6,812	1,433	27,733	16,065	<b>127,093</b>
2011	1,038	25,331	1,267	30,937	5,444	1,725	26,446	12,862	<b>105,050</b>
2012	734	10,810	1,171	18,973	3,473	899	21,594	11,812	<b>69,466</b>
2013	453	9,145	884	13,410	2,983	827	19,608	10,989	<b>58,299</b>
2014	451	9,641	1,026	13,433	1,930	962	20,613	10,672	<b>58,728</b>
2015	572	8,612	1,063	11,805	2,557	803	23,087	10,205	<b>58,704</b>
2016	676	8,574	919	11,424	2,280	946	27,652	9,429	<b>61,900</b>
2017	458	6,428	639	9,406	1,913	745	18,707	7,040	<b>45,336</b>
<b>Total</b>	<b>10,694</b>	<b>269,123</b>	<b>18,663</b>	<b>268,786</b>	<b>58,875</b>	<b>12,673</b>	<b>270,609</b>	<b>167,656</b>	<b>1,077,079</b>

<sup>51</sup> Clean Energy Regulator.

# WIND POWER



While large-scale solar has made some rapid advances in the last few years, wind power is still the lowest-cost renewable energy possible to roll out on a large scale. For the first time ever, 2017 saw wind contribute an almost identical amount of Australian electricity as hydro energy.

**15**

new wind farms under construction or financially committed at the end of 2017

**4816**

megawatts of generating capacity now installed across the country

2017 saw a tremendous amount of activity in the wind sector, with 15 new wind farms either under construction or financially committed at the end of the year.

The 547 MW of new capacity added in 2017 was the third-highest amount added in the history of the Australian wind industry, but is expected to be dwarfed by the current program of works in the next few years. A total of 4816 MW of generating capacity has now been installed across the country.

The largest project in 2017 was the Ararat Wind Farm, with Neoen's Hornsdale 2 and 3 projects also significant additions.

## TOP FIVE PLANTS BY SIZE

MACARTHUR, VIC  
Owner: AGL  
Commissioned: 2012  
**420 MW**

SNOWTOWN 2, SA  
Owner: Trustpower  
Commissioned: 2014  
**270 MW**

ARARAT, VIC  
Owner: RES  
Commissioned: 2017  
**240 MW**

COLLGAR, WA  
Owner: UBS IIF / REST  
Commissioned: 2012  
**206 MW**

WAUBRA, VIC  
Owner: ACCIONA Energy  
Commissioned: 2009  
**192 MW**







**33.8%**  
of total clean  
energy generated in  
Australia in 2017



**5.7%**  
of total Australian  
electricity generated  
in 2017



Image: Walkaway Wind Farm, Western Australia

TECHNOLOGY PROFILES  
**WIND POWER** (CONTINUED)

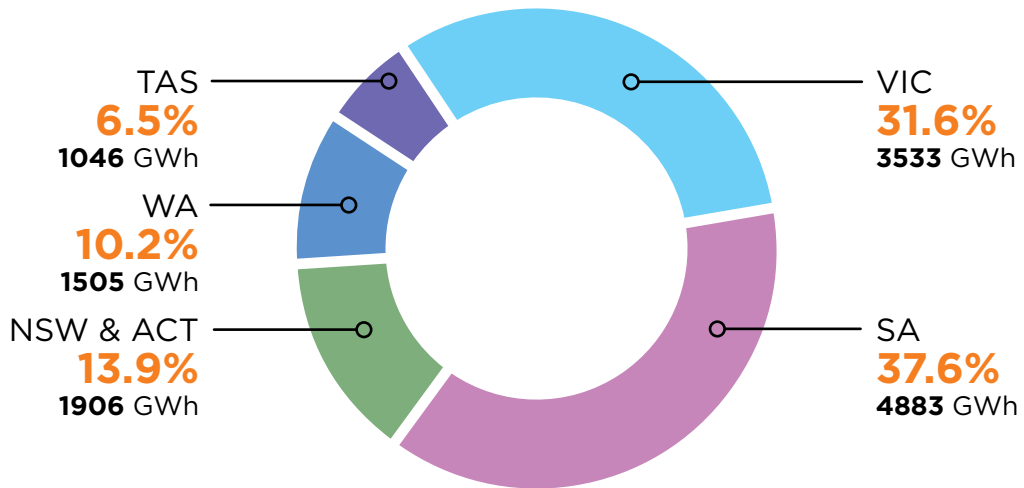
**WIND FARMS COMMISSIONED IN 2017**

OWNER	PROJECT	LOCATION	STATE	CAPACITY (MW)
RES	Ararat Wind Farm	Ararat	VIC	240
Neoen/Megawatt Capital	Hornsedale Stage 2	Hornsedale	SA	109
Neoen/Megawatt Capital	Hornsedale Stage 3	Hornsedale	SA	100
Windlab	Kiata Wind Farm	Kiata	VIC	31
EDL	Cooper Pedy Renewable Hybrid Project	Cooper Pedy	SA	5
Hydro-Electric Corporation	Whitemark Power Station	Bass Strait Islands	TAS	4

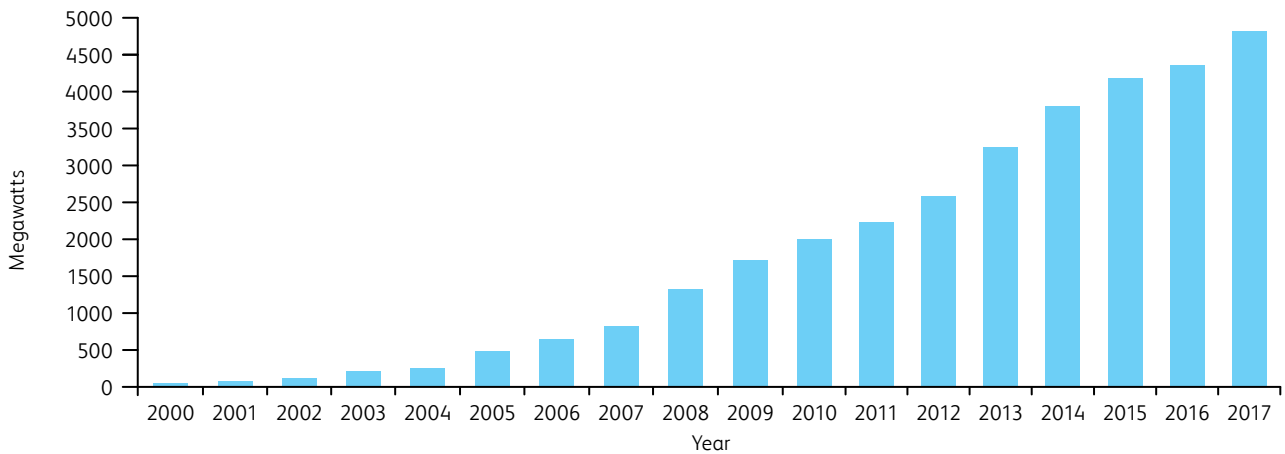
**WIND FARMS UNDER CONSTRUCTION AND COMMITTED AT END 2017**

OWNER	LOCATION	STATE	INSTALLED CAPACITY (MW)
Powering Australian Renewables Fund	Coopers Gap	QLD	440
CWP Renewables	Sapphire	NSW	270
AGL	Silverton	NSW	199
RATCH-Australia	Mt Emerald (Arriga)	QLD	181
Goldwind Australia	White Rock	NSW	175
ACCIONA	Mt Gellibrand	VIC	132
Engie	Willogoleche Hill	SA	119
Infigen	Bodangora (Wellington)	NSW	113
Global Power Generation	Crookwell 2 (Goulburn)	NSW	91
Pacific Hydro	Crowlands	VIC	80
Tilt Renewables	Salt Creek	VIC	58
Windlab/Eurus	Hughenden	QLD	43
Pacific Hydro	Yaloak	VIC	29
Future Energy	Maroona	VIC	6

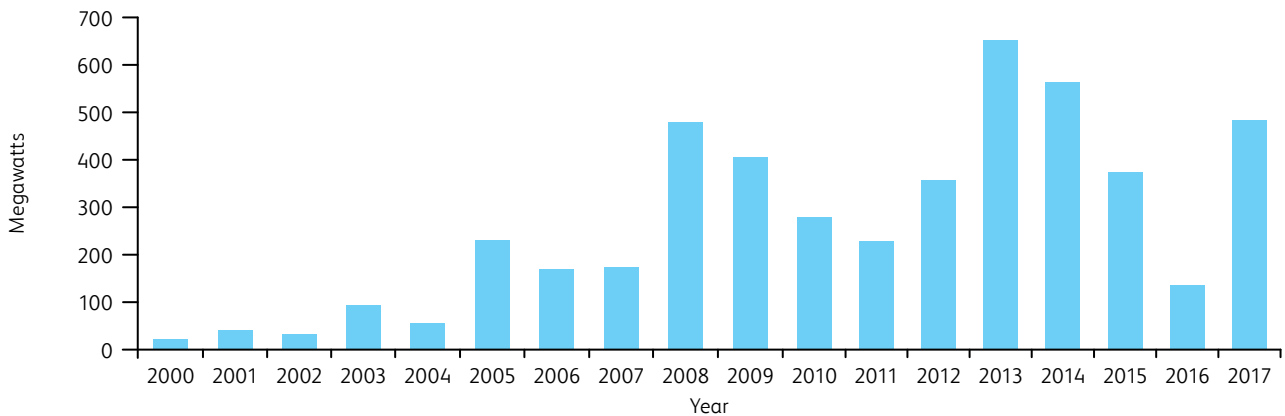
## PERCENTAGE OF WIND GENERATION BY STATE<sup>52</sup>



## CUMULATIVE INSTALLED WIND CAPACITY IN AUSTRALIA<sup>52</sup>



## ANNUAL INSTALLED WIND CAPACITY IN AUSTRALIA<sup>52</sup>



<sup>52</sup> AEMO, Clean Energy Council Renewable Energy Database.

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

- > ACCIONA Australia
- > Autonomous Energy
- > Coffs Solar Energy
- > Genex Power
- > Goldwind Australia
- > Hydro Tasmania
- > Infigen Energy
- > MAKO Tidal Turbines
- > Neoen
- > Pacific Hydro
- > Sandfire Resources
- > Snowy Hydro
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- > Tilt Renewables

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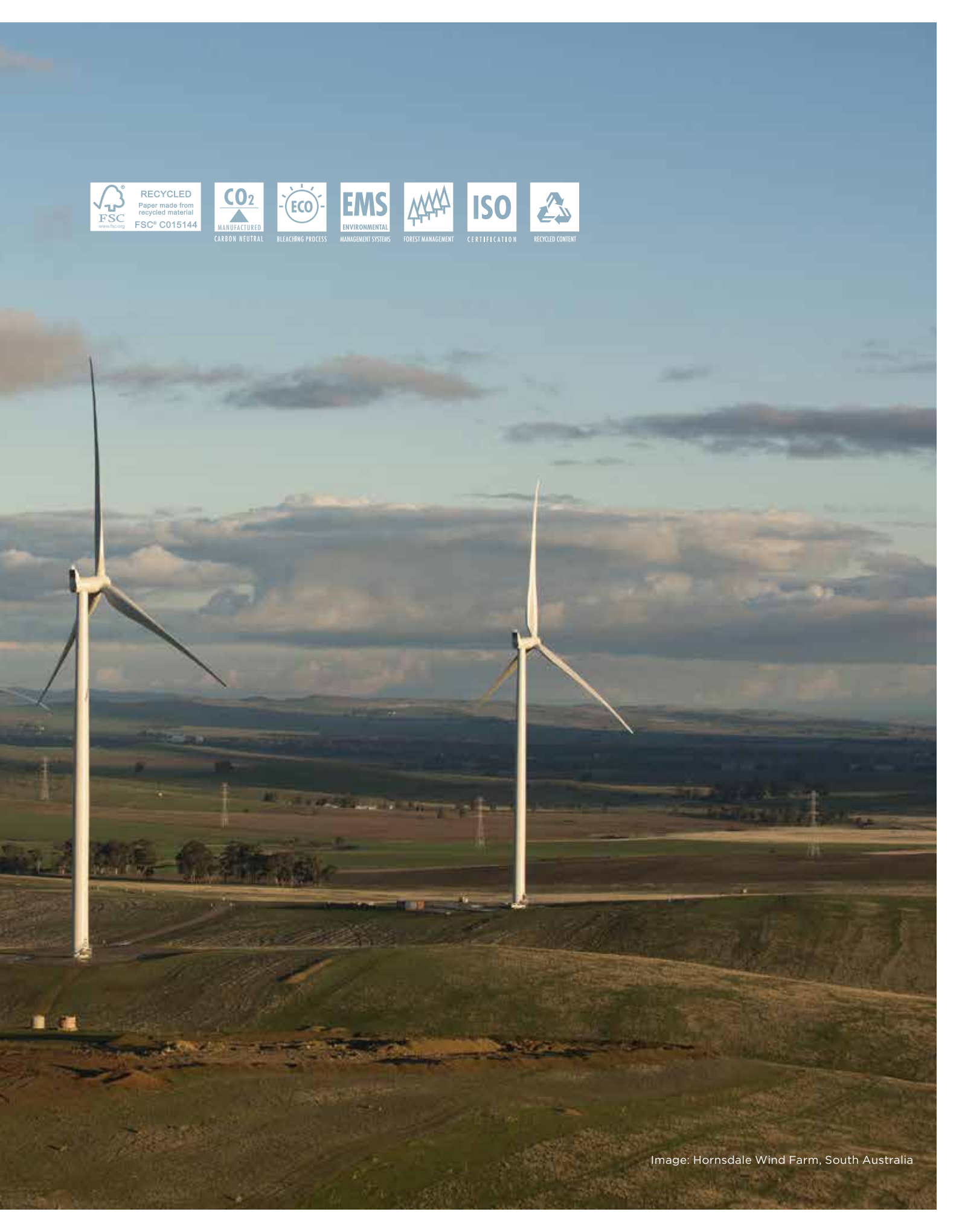
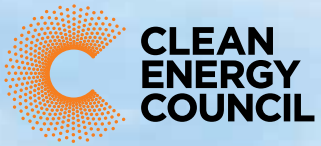


Image: Hornsdale Wind Farm, South Australia



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