Clean Energy Australia

2025

CLEAN ENERGY COUNCIL


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Constructing our future together

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We respectfully acknowledge Aboriginal and Torres Strait Islander peoples as the Traditional Custodians of the lands and waters on which we work and live. We commit to collaborate with First Nations communities, to promote sustainable practice, protect ancient sites and culture with equitable access to the benefits of clean energy. Sovereignty has never been ceded.

We acknowledge Elders, past and present, and their continuing culture and connection to Country.

← Cover image:
Bundaberg Solar Farm
Bundaberg, QLD
Taribelang Country
(Monford Group)

Culcairn Solar Farm
Culcairn, NSW
Wiradjuri Country
(Neoen)

Contents

INTRODUCTION

A message from our CEO

Clean energy investment soared in 2024, led by a strong uptick in new financial commitments to large-scale generation, another strong year for big batteries and rooftop solar surging past 4 million installations

In 2024, we saw a considerable increase in investment commitments to large-scale renewable energy generation – a 500 per cent uptick from $1.5 billion in 2023 to approximately $9 billion in 2024. That is the highest single year of new financial commitments to large-scale generation since the boom of 2018 ($8.4 billion). When combined with utility scale storage investment commitments, 2024 saw the largest wave of clean energy investment in Australia's history.

This reflects improving economic conditions after multiple years of high inflation increased the costs of financing, technologies, materials and labour. It also reflects the improving policy landscape for clean energy in Australia, with transmission build underway and a clear commitment – through the expansion of the Capacity Investment Scheme (CIS) – to support 23 GW of large-scale generation and 9 GW of storage into the market by 2030.

In late 2024, the results of the first round of tenders in that scheme were announced. Nineteen renewable energy projects were selected, representing 6.4 GW / 3.6 GWh of capacity. It is too early to say the scheme is fully delivering, but the early signs are very positive. Investment needs certainty, and we are seeing more of that.

Combined large- and small-scale capacity that commenced generation in 2024 was approximately 5.2 GW, down on 5.9 GW in 2023. This was comprised of 3.2 GW of rooftop solar and 2 GW of utility scale capacity.

5.2 GW

Renewable generation capacity added in 2024

(2023: 5.9 GW)

3.2 GW

Capacity added by rooftop solar in 2024

(2023: 3.1 GWh)

$9 billion

New financial commitments to large-scale renewable energy generation projects in 2024

(2023: $1.5 billion)

8.7 GW/ 23.3 GWh

approximate capacity of large-scale batteries under construction at end of 2024

(2023: 5 GW /12 GWh)

Rooftop solar soars

The rooftop solar industry surpassed four million installations on households and small businesses in 2024, solidifying Australia's position as a world leader in the sector. With 3.2 GW of capacity added to the grid, very close to the record of 2021, rooftop solar continued to lead Australia's energy transition, as it has since 2019, which was the last year rooftop solar and utility scale generation provided roughly equal levels of new capacity.

There were 332,016 rooftop solar installations in 2024, slightly down on 2023, although the capacity added by those installations was higher than 2023 as the average size of solar installations continued to trend upwards. These are numbers for Australia to be proud of and are a testament to the value Australians see in rooftop solar in terms of lowering energy bills and greater energy independence, and of course to the hard work of over 10,000 installers and thousands of retailers across the country. 2024 was the fifth year in a row with more than 300,000 solar installations.

More than 4 million households and small businesses are already saving $6 billion a year by having solar on their roof.

The story for new large-scale generation connected to the grid in 2024 is more mixed, with 2 GW of capacity added, down on 2.8 GW in 2023. Approximately 1.3 GW came from large-scale solar and 836 MW from wind – both down on 2023 (1.9 GW and 942 MW respectively). Many of the headwinds for large-scale energy projects remain from recent years, including slow planning and environmental assessment processes in some jurisdictions, higher costs and tighter markets for equipment and labour.

Renewable energy provided 40 per cent of Australia's total electricity generation in 2024, up from 39.4 per cent in 2023.

According to forecasts by the Australian Energy Market Operator in its *2024 Integrated System Plan*, Australia will need to add approximately 6 GW of utility scale generation each year by 2030 to ensure retiring coal generation is being replaced. The 2024 total of 2 GW represents solid progress but clearly is significantly below the rate required, though the increase in projects reaching financial close (as a leading indicator) is cause for optimism that this level of development is achievable.

It is critical that industry, governments, communities and other stakeholders work together to maintain the momentum that has been built in recent years and double down on Australia's extraordinary clean energy potential.

Clean energy momentum

The Clean Energy Council, alongside our valued members, is more committed than ever to realising that potential and accelerating the rollout of renewable energy and energy storage for the benefit of all Australians. By bringing economic benefits, tens of thousands of new jobs, lower energy bills, and of course critical greenhouse gas emissions reduction – clean energy works for Australia.

For more information on the Clean Energy Council, including 2024 highlights and our slate of upcoming events, see page 89.

Kane Thornton
Chief Executive
Clean Energy Council

INTRODUCTION

2024 Snapshot

Rooftop solar raced past 4 million installations and continues to drive Australia's clean energy transition, while new investment in utility scale generation and storage combined was the highest on record.

Renewable energy provided 40 per cent of Australia's total electricity generation in 2024, up on 39.4 per cent in 2023. The makeup of that generation is largely unchanged from 2023, with wind the single-largest sector, at 13.4 per cent, followed by rooftop solar, at 11.2 per cent.

In 2024, rooftop solar was once again the driving force of Australia's clean energy transition in terms of capacity added. Utility scale generation capacity added was down on 2023, but we saw the best investment figures since the highs of the clean energy boom in 2018, when Australia was striving to meet the Renewable Energy Target. Meanwhile, there were more strong investment numbers for utility scale battery storage after a record-breaking 2023.

Generation capacity added in 2024 was 5.2 GW, down from 5.9 GW in 2023. Of that 5.2 GW, 3.2 GW was provided by rooftop solar, and 2 GW from large-scale generation. In 2023, rooftop solar provided 3.1 GW and large-scale generation 2.8 GW. The record for generation capacity added in a single year remains 2021, when a total of 6.3 GW was added to the grid.

The Australian Energy Market Operator forecast in its *2024 Integrated System Plan* [1] that Australia would need to add approximately 6 GW of utility scale generation capacity each year to replace ageing coal generation. The 2024 figure of 2 GW for commissioned wind and large-scale solar combined is the lowest since 2020, noting the strong uptick in new projects reaching financial close in 2024 is cause for considerable optimism.

[1] Australian Energy Market Operator, *2024 Integrated System Plan*

40%

Australia's electricity generation from renewable sources, 2024

(2023: 39.4%)

27,126 GWh

NSW renewable energy generation, highest of Australian states

(2023: 24,985 GWh)

3.2 GW

Rooftop solar capacity added in 2024

(2023: 3.1 GW)

59

Large-scale generation projects under construction at the end of 2024

(2023: 56)

Australia produced more renewable electricity than ever before in 2024, with over 97,200 GWh going into the grid. That is an increase of more than 30 per cent since 2021.

Meanwhile, in the final quarter of 2024, renewable energy provided a record 46 per cent of Australia's electricity supply, and coal-fired generation fell below 50 per cent for the first time. This was partly a result of growth in distributed solar output and reduced coal availability. During Q4 2024, both rooftop solar and utility scale solar reached new output records, increasing by 19 per cent and 9 per cent respectively.[2]

Rooftop solar smashes four million installs

At 3.2 GW of installations, rooftop solar was the largest single category of new renewable energy generating capacity added in 2024 – as it has been every year since 2019. Rooftop solar now equates to more than 25 GW of installed capacity in Australia – more than black and brown coal combined. In 2024 it accounted for 31 per cent of all renewable energy generated, and 12.4 per cent of electricity generation overall, up from 28.5 per cent and 11.2 per cent respectively in 2023.

Rooftop solar surpassed a huge milestone in 2024, with over four million rooftop solar systems now installed on households and small businesses. By the end of 2023, there were approximately 3.7 million systems installed. The total number of new rooftop solar installations in 2024 was 332,016 , slightly down on 333,717 in 2023. The capacity added by those systems, however, was 3.2 GW, up from 3.1 GW in 2023, as the average size of rooftop solar systems continued to trend upwards and is now within a whisker of 10kW (9.98 kW), compared to 8.01 kW in 2023.

2024 was the fifth straight year that more than 300,000 solar installations were completed, and the fifteenth straight year that the average size of solar systems has increased.

Household battery uptake also continued to show significant growth. The latest figures from SunWiz show that 185,798 units are now installed across Australia, and in the second half of 2024, 28.4 per cent of rooftop solar installations had an accompanying household battery installed. In total, 74,582 home batteries were sold in Australia in 2024, up from approximately 46,000 in 2023.

Large-scale pipeline is strong

Two GW of large-scale wind and solar were connected to the grid in 2024, down on 2.8 GW in 2023. That generation capacity came from 21 completed projects. Of the total capacity added, 238 MW came from large-scale solar, and 836 MW from wind. Both of those figures are down on 2023, when large-scale solar contributed 2.1 GW, and wind 946 MW.

Fourteen large-scale solar projects were commissioned in 2024, one more than in 2023. Queensland installed the most new capacity, with three projects totalling 385 MW. Western Australia commissioned the most projects, with six, with a combined capacity of 262 MW. The largest project commissioned was BJEI Australia's 330 MW Wellington North Solar Farm in New South Wales. The project is now the third-largest operational solar farm in Australia. Medium- and large-scale solar farms now provide 7.2 per cent of Australia's electricity, up from 7 per cent in 2023.

The 836 MW from wind came from six projects – one fewer than in 2023. The largest wind farm commissioned in 2024, in terms of capacity, was Tilt Renewables' 396 MW Rye Park Wind Farm in New South Wales. Wind provides 13.4 per cent of Australia's electricity, the same percentage as in 2023. There was also one solar/wind project completed – Zenith Energy's 41 MW Jundee Hybrid Project in Western Australia.

There were 59 large-scale renewable energy projects under construction as of December 2024, up from 56 at the same point in 2023. The combined capacity of those projects is approximately 9.9 GW – a marked improvement on the 2023 figure of 7.5 GW. Thirty-nine of those projects are large-scale solar farms (up from 38 in 2023), 18 are wind projects (up from 13 in 2023) and the remaining two are biomass projects.

In 2024, construction commenced on 22 renewable energy projects for a combined 3.6 GW of capacity – a noteworthy improvement on 2.7 GW in 2023. The record for construction commencements in a single year remains 2022, at 5 GW.

While 2024 may not have been a standout year for new generation capacity added, it was a significant turning point for new financial commitments, which is an important leading indicator for the sector and Australia's energy transition. See below for details on a strong year for new financial commitments to large-scale generation projects.

Another bumper year for battery storage

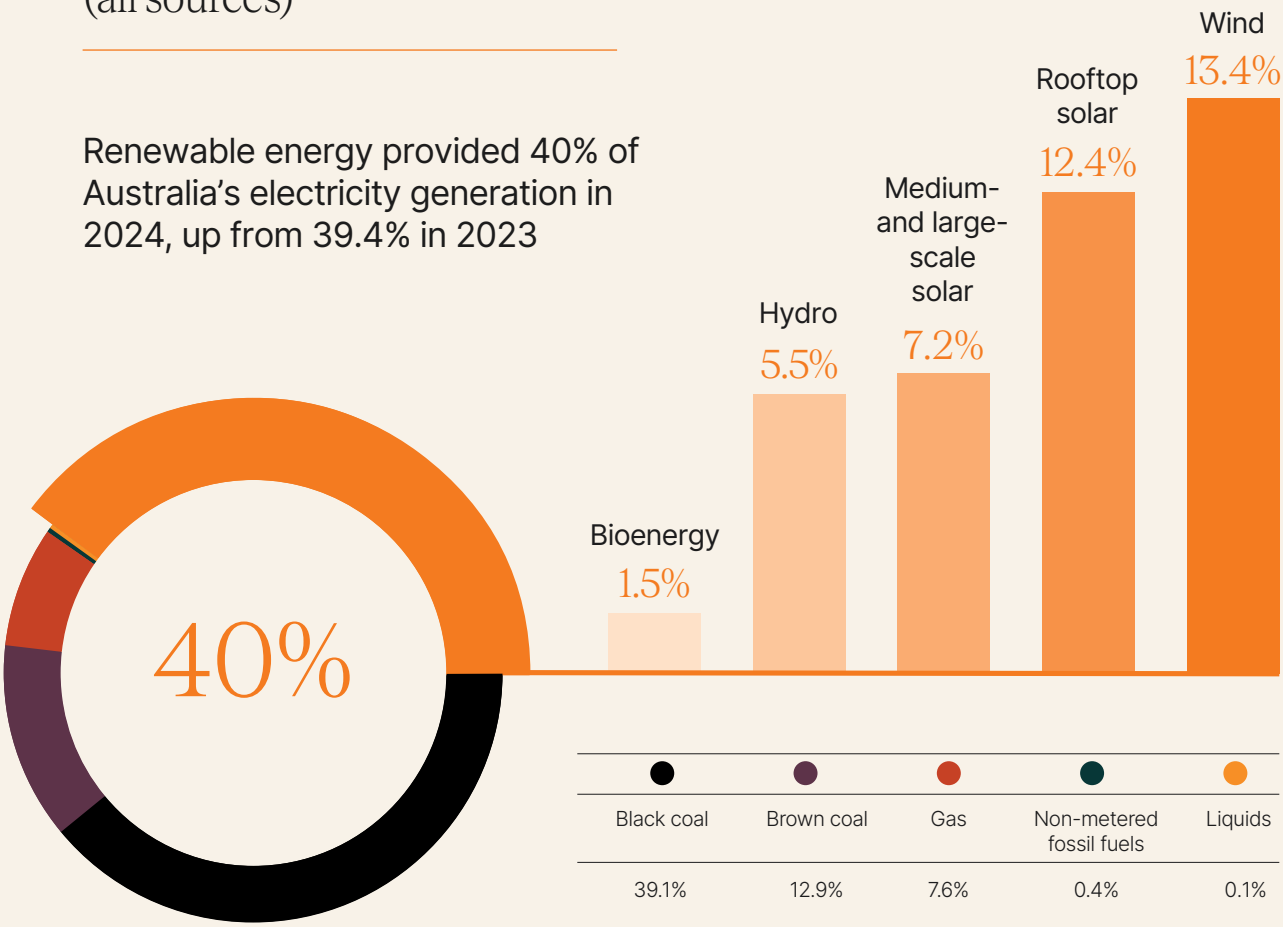
Thirty-eight large-scale batteries were under construction at the end of 2024, up from 27 at the end of 2023, which was up from 19 in 2022. The combined capacity of those 38 projects will be 8.7 GW / 23.3 GWh, up from 5 GW / 12 GWh in 2023.

The 850 MW / 1,680 MWh Waratah Super Battery in New South Wales remains the largest project in development by capacity, with that project having completed construction and now in the process of being commissioned. The next-largest is the 600 MW / 1,600 MWh Melbourne Renewable Energy Hub Battery Energy Storage System (Phase 1) in Victoria. The 38 batteries under construction are spread fairly evenly around Australia.

[2] Australian Energy Market Operator, *Quarterly Energy Dynamics Q4 2024*

Electricity generation in 2024 (all sources)

Renewable energy provided 40% of Australia's electricity generation in 2024, up from 39.4% in 2023



Five utility scale battery storage projects were connected to the grid in 2024, for a combined capacity of 619 MW / 1,677 MWh. The final quarter of 2024 was a record-breaking one, as more than 1 GWh worth of battery projects came online in a single quarter for the first time. Those projects were the Rangebank BESS in Victoria (200 MW / 400 MWh) and the Collie Battery – Stage 1 in Western Australia (219 MW / 877 MWh).

As of the end of 2024, there is over 8.7 GW / 23.3 GWh of large-scale battery capacity under construction in Australia. That is not only more big battery storage than is currently operational in Australia – it's more than a third of Australia's coal-fired power stations combined.

At $3.7 billion, investment in utility scale batteries is down on the record-breaking $6.9 billion in 2023. That is still a huge number, however, and is most likely significantly higher as not all projects which reached financial commitment in 2024 had publicly disclosed investment figures at the time of writing. The largest project, by capacity, to be financially committed is Akaysha Energy's Orana Battery Energy Storage System, at 415 MW / 1,660 MWh. According to Akaysha Energy, this is the largest investment in a single battery anywhere in the world.

The $3.7 billion of new commitments is divided between 24 battery storage projects, and the combined capacity of those projects (4 GW / 11.3 GWh) is more than the capacity of all battery storage systems currently operational in Australia, suggesting the pipeline is extremely strong.

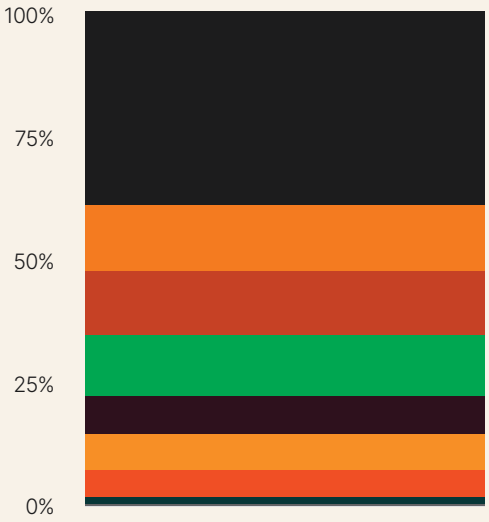
Clean energy investment soars

Fortunately, 2024 was significantly stronger than 2023 for new financial commitments to renewable energy projects, with over $9 billion worth of projects reaching financial close representing 4.3 GW of new generation capacity. This is the largest figure since 2018, when approximately $10.1 billion was invested in new generation projects.

If storage is included, the total figure for 2024 is approximately $12.7 billion – the highest single-year investment figure for clean energy in Australia. Soaring investment is a welcome improvement from the combined (generation plus storage) total in 2023, which was already significant at $8.3 billion.

Thirteen large-scale solar projects reached financial commitment in 2024, for a combined capacity of 1.9 GW – significantly up from seven new commitments in 2023, for 921 MW. The wind sector, meanwhile,

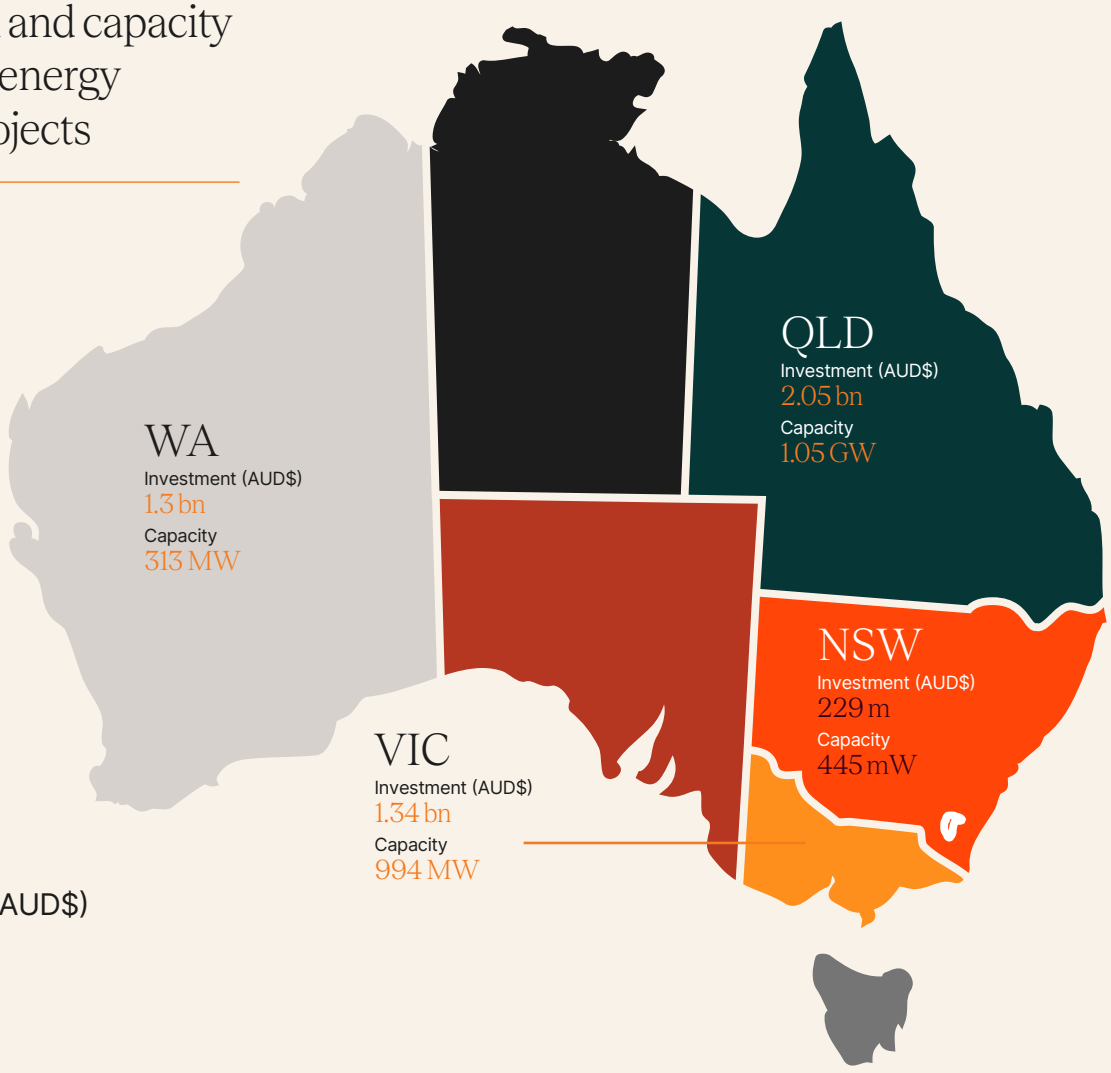
Australia's electricity generation mix in 2024 (fuel types by MWh)



Type of Fuel	Total MWh	MWh %
Black Coal	95,035,772	39.1%
Wind	32,518,669	13.4%
Brown Coal	31,448,666	12.9%
Roof solar	30,178,272	12.4%
Gas	18,480,447	7.6%
Solar	17,624,512	7.2%
Hydro	13,294,907	5.5%
Bioenergy	3,599,099	1.5%
Non-metered fossil	883,668	0.4%
Liquids	130,106	0.1%
Total	**243,194,117**	**100.0%**

Investment in and capacity of large-scale energy generation projects

Projects currently at financial commitment
(2017 to 31 December 2023)



Total investment (AUD$)
4.92 bn
Total Capacity
2.8 GW

Blue Grass Solar Farm
Chinchilla, QLD
Barunggam Country
(X-ELIO)

2 GW

Total capacity of large-scale renewable projects completed in 2024

(2023: 2.8 GW)

Renewable energy projects completed in 2024

Tech	State	Project	Lead Operator-Owner	Capacity (MW)
Wind	NSW	Rye Park Wind Farm	Tilt Renewables	396
Solar	NSW	Wellington North Solar Farm	BJEI Australia	330
Solar	QLD	Woolooga Solar Farm	Lightsource BP	176
Wind	VIC	Mortlake South Wind Farm	Acciona	157
Wind	NSW	Flyers Creek Wind Farm	Iberdola Australia	145
Solar	QLD	Wandoan Solar Farm Stage 1	Vena Energy	125
Solar	VIC	Glenrowan Solar Farm	Pacific Partnership (CIMIC Group)	102
Solar	WA	North Star Junction	Fortescue Metals Group	100
Solar	SA	Tailem Bend Solar Farm Stage 2	Vena Energy	87
Solar	QLD	Moura Solar Farm	Mytilineos SA	84
Wind	WA	Flat Rocks Wind Farm - Stage 1	Potentia Energy	76
Solar	NSW	Wyalong Solar Farm	Mytilineos SA	52
Solar	WA	Tropicana-Solar Project	Pacific Energy	24
Solar	WA	Port Hedland Power Station	APA Group	45
Solar/Wind	WA	Jundee Hybrid Project	Zenith Energy	40
Wind	WA	Kathleen Valley Power Station - Wind	Zenith Energy	30
Solar	SA	Mannum Adelaide Pumping Station No 3 (MAPL3)	SA Water Corporation	16
Solar	WA	Kathleen Valley Power Station - Solar	Zenith Energy	16
Solar	WA	Bluebird Solar Farm	Pacific Energy	12
Solar	VIC	Winneke Water Treatment Plant	Melbourne Water Corporation	9
Wind	WA	Moora Energy Windfarm	Moora Energy Pty Ltd	7

bounced back strongly, with eight new financial commitments, up from zero in 2023.[3] Those projects will amount to 2.2 GW of new generation capacity.

In late 2024, the first tender round for generation through the Capacity Investment Scheme (CIS) – the Australian Government's revenue underwriting scheme for large-scale generation and storage – was announced. The 19 projects selected have a combined generation capacity of 6.4 GW / 3.6 GWh.

With this support, these projects are now expected to move to financial close, giving cause for much optimism about the levels of utility scale generation expected to reach financial close in 2025 and beyond.

For more information on the various sectors in Australian clean energy, turn to the tech profiles from page 52 onwards.

Fossil fuels and international renewables

The amount of coal-fired generation in Australia's electricity system fell 52 per cent in 2024, down from 52.7 per cent in 2023; however, gas-fired power generation rose from 7.3 per cent in 2023 to 7.6 per cent in 2024, as a number of coal-fired generation outages and lower wind resources in the first half of 2024 increased the demand for gas-fired power generation. After 2023 became the first year in which renewables generated more electricity than black coal, the trend continued in 2024 and now looks to be the norm. The next milestone will likely be when black and brown coal combined, provide less than half of Australia's electricity.

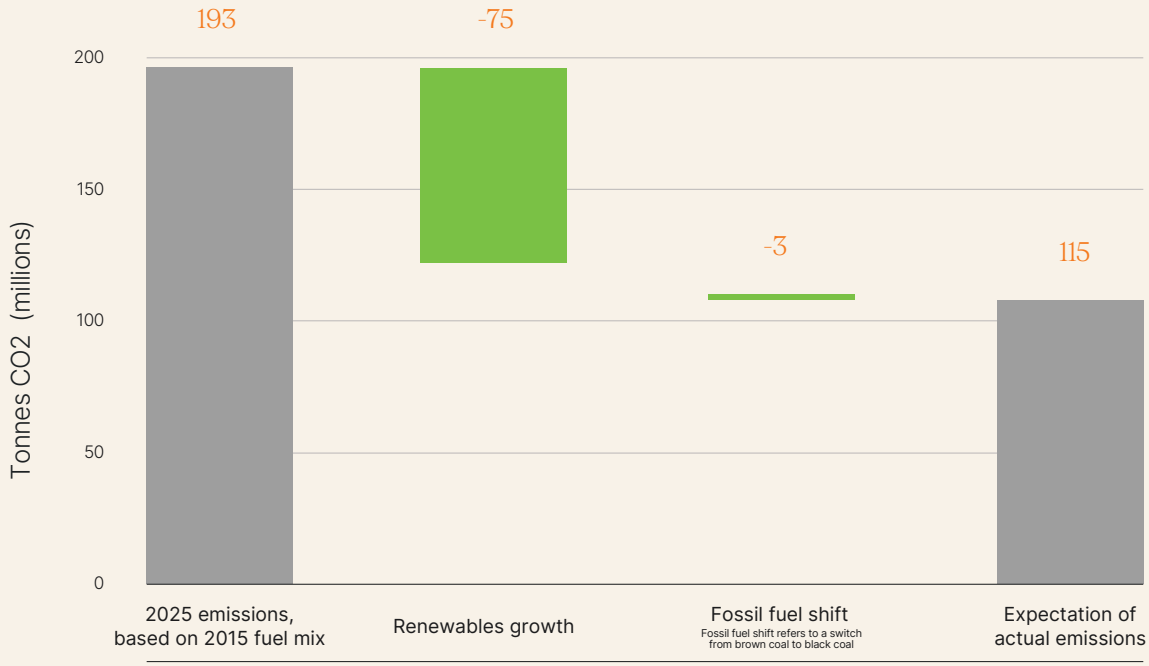
According to forecasting by the International Energy Agency (IEA), around 666 GW of renewable capacity was added globally in 2024, significantly up on approximately 510 GW in 2023. That figure could stand at around 935 GW by 2030, according to the IEA.

Investment in the global energy transition exceeded USD $2 trillion for the first time in 2024, according to BloombergNEF, with electrified transport (USD $757 billion) making up the largest portion of that total. Renewable energy investment, at USD $728 billion, was the second largest. Despite these astonishing figures, however, BloombergNEF predicts that global spending would need to almost triple if we are to reach global net zero by 2050.

Contributions from the United States to investment in the energy transition have tended to be very high. The full effects of the Trump Administration's policy agenda on the US' energy transition and clean energy investment remains to be seen.

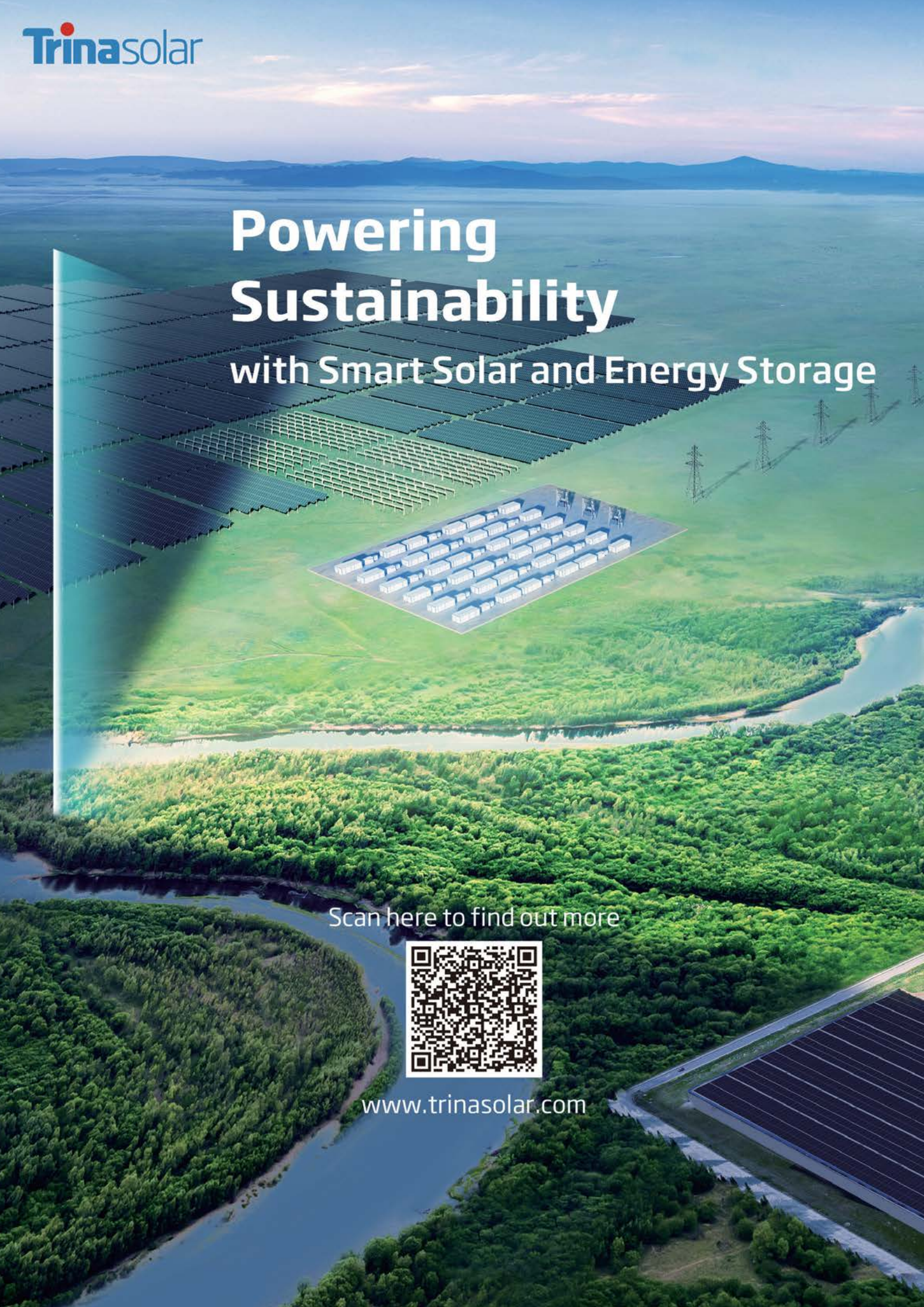
For more on international renewables in 2024, see page 49.

Expected reduction in 2025 electricity emissions due to change in generation fuel mix since 2015



A Clean Energy Council report, *Emissions reductions delivered by renewable energy, 2015-25,* revealed that by the end of 2025, emissions will be 40 per cent lower in Australia thanks to the installation of renewable energy projects and solar systems since 2015, resulting in a saving of 340 million tonnes over the decade from 2015-25. For more information, read the full report on the Clean Energy Council website.

[3] The Uungula wind farm reached financial close in late 2023 but was not publicly announced until 2024, meaning it was not captured in our 2023 data.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INDUSTRY OUTLOOK

Small-scale renewable energy

Australia surpassed four million rooftop solar installations in 2024, and for the fifth year running rooftop solar led the energy transition in capacity added.

Rooftop solar installations on households and small businesses passed four million in 2024 – an outstanding achievement that is representative of the value consumers see in rooftop solar, for lowering bills and for increasing energy independence. It is also testament to the hard work of over 10,000 installers and thousands of retailers across the country.

Rooftop solar generated 31 per cent of clean energy in Australia in 2024 (up on 28.5 per cent in 2023) and 12.4 per cent of Australia's electricity overall (up on 11.2 per cent in 2023). It is the second-largest source of renewable generation in Australia, after wind at 13.4 per cent, with the gap between them closing over recent years.

In 2024, 322,016 solar PV systems were installed, slightly down on 333,717 systems in 2023. But the headline figure is that those systems provided a total installed capacity of 3.2 GW (up from 3.1 GW in 2023), coming very close to the record set in 2021. This is because the average size of solar installations has continued to trend upwards and is now 9.98 kW compared to 9.41 kW in 2023. This was the fifteenth straight year that the average size of solar systems increased, and the fifth year in a row that installation figures surpassed 300,000 units.

In 2024, New South Wales became the second state to pass one million rooftop solar installations, following Queensland in 2023. It added the highest amount of rooftop solar installations, at 98,531, with QLD in second place at 82,301. QLD still leads the country for overall installations, at 1.09 million, but NSW has added the most installations each year since 2018 and is not far behind at 1.06 million.

332,016

rooftop solar installations in 2024

(2023: 333,717)

3.2 GW

rooftop solar capacity added in 2024

(2023: 3.1 GW)

4 million

More than 4 million Australian households and small businesses with rooftop solar

(2023: 3.7 million)

NSW installed over a gigawatt of rooftop solar capacity for the second year running, coming in just shy of the total it set in 2023, which remains a single-year record. The only other states to install less capacity in 2024 than in 2023 were the ACT (50.1 MW versus 85 MW) and South Australia (261 MW versus 263 MW) though these drop-offs were minor.

Of the 5.2 GW of new capacity added to the grid in 2024, 3.2 GW came from rooftop solar – the fifth year running that rooftop solar has outperformed utility scale renewables in terms of capacity added. The 1.2 GW difference between large-scale and small-scale is notably larger than in recent years – 0.3 GW in 2023 and 0.4 GW in 2022. That gap may close over the coming years as the investment landscape for large-scale renewables looks to be picking up sharply.

The latest figures from SunWiz for household battery installations are also very positive, with 185,798 units now installed across Australia. The second half of 2024 saw 45,233 units sold – 85 per cent more than the same half in 2023. In total, 74,582 home batteries were sold in Australia, up from approximately 46,000 in 2023.

Around 4.6 per cent of the 4 million solar installations have a battery connected, and in 2024, around 23 per cent of installations came with an attached battery, showing the significant growth of the sector. As with the large-scale sector, battery storage is critical to absorbing energy and distributing it when and where it is needed most.

Many state governments have supported home batteries with state-specific battery rebate schemes, including the ACT, Queensland, South Australia and Victoria. More recently, New South Wales has shown support through its Peak Reduction Scheme.

The landscape is ripe for a nationally coordinated battery rebate program delivered through the highly successful Small-scale Renewable Energy Scheme (SRES) to build on the success of the State schemes, as well as continued focus on encouraging more orchestration of rooftop solar and storage, driven by informed consumers who have trust in the installation and service delivery processes.

Industry support

The New Energy Tech Consumer Code (NETCC), launched in early 2023, is a set of guidelines and principles designed to ensure that consumers purchasing new energy technologies and services such as solar systems, batteries and electrical vehicle supply equipment are treated fairly and transparently. The NETCC coverage of consumer protections goes beyond solar and storage products, and includes many other behind-the-meter products and services, ensuring more Australian homes and businesses can access clean, affordable, new energy tech from trusted companies. The program is designed and governed by the NETCC Council and administered by the Clean Energy Council (CEC).

In 2024, the NETCC received 416 applications from businesses wishing to join the program, of which 356 have been approved. By the end of 2024, 1,698 companies were participating in the NETCC program. The majority of approved NETCC sellers (61 per cent) are in Victoria, followed by New South Wales with 14 per cent, then Queensland with 11 per cent.

The NETCC continued its rigorous compliance activity in 2024, opening 275 NETCC compliance cases against Approved Sellers, of which 74 resulted in compliance action . These actions are crucial to maintaining the integrity of the sector.

The Administrator launched the NETCC compliance auditing program in H2 of 2024. The audits aim to proactively identify compliance gaps and assist NETCC Approved Sellers by applying a support-to-comply approach. This provides learnings that help improve how businesses sell new energy tech products and services. There are two types of audits the Administrator conducts.

> “2024 was the 15th straight year that the average size of solar systems increased, and the fifth year in a row that installation figures surpassed 300,000 units

Competency Audits consist of a multiple-choice questionnaire to be completed by randomly selected Approved Sellers. The questionnaire is designed to test the Seller’s knowledge of the NETCC, is time restrained, and requires a minimum score of 80 per cent to pass. Failure to pass or cooperate and complete the questionnaire results in a competency audit case being opened against the Approved Seller.

Robust Audits require selected Approved Sellers to submit recently used new energy tech sales documentation. The Administrator assesses the documentation and the Seller’s online presence against key requirements of the NETCC under a robust audit case. Approved Sellers can be selected at the Administrator’s discretion, including those with a history of non-compliance.

The second half of 2024 saw the Administrator open 52 competency audit cases and 16 robust audit cases. The Administrator closed 23 competency audit cases and 9 robust audit cases following an investigation.

These actions were vital to maintaining the program's integrity and ensuring that Australian consumers purchasing new energy tech products, systems and services including solar panels, batteries and invertors had confidence that NETCC-endorsed sellers had a commitment to good practice standards. To support sellers in adapting to the NETCC program, the CEC took a support-to-comply approach for compliance outcomes in the first six months of the NETCC's operation.

Product accreditation

The Clean Energy Council maintains a list of approved products that are eligible for installation, based on their compliance with Australian and International Standards. The CEC's product accreditation program is delivered in collaboration with government, electrical safety regulators, certifiers, network providers and product manufacturers to ensure only approved products enter the Australian market. The Clean Energy Council's approved product list includes inverters and power conversion equipment, solar PV modules and energy storage devices.

Following the Clean Energy Regulator's call for application and evaluation for the Product Listing Body for small-scale renewables, such as solar PV and inverters, under the Small-scale Renewable Energy Scheme (SRES), the Clean Energy Council was reappointed by the Clean Energy Regular to continue its role as the Product Listing Body for SRES as of October 2024.

In 2024, the CEC received 526 product listing applications, while 385 applications were approved. There are currently 4,829 approved rooftop solar, inverter and storage products across Australia.

Product listing applications received and approved in 2024

Product category	Number of applications received	Number of applications approved
Inverters	173	104
PV modules	217	211
Batteries	136	70
Total	**526**	**385**

Number of models listed approved and total number of models listed in 2024, by product category

Product category	Models approved in 2024	Total models listed in 2024
Inverters	455	637
PV modules	2,174	1,707
Batteries	258	2,485
Total	**2,887**	**4,829**

Tropicana Wind Farm
Great Victoria Desert, WA
Wongatha Country
(Pacific Energy)
Pacific Energy's Tropicana wind farm is powered by Goldwind wind turbines

INDUSTRY OUTLOOK

Large-scale renewable energy

Only a modest amount of new large-scale generation capacity was commissioned in 2024, but significant levels of new financial commitments point to a promising future.

Large-scale renewable energy projects completed in 2024 provided a combined 2 GW of generation capacity across 21 projects. The number of projects was slightly down on 22 in 2023, while capacity added was more significantly down, compared to 2.8 GW in 2023.

Of the 21 projects commissioned in 2024, 14 were large-scale solar plants, six were wind projects, and there was one hybrid solar/wind project – Zenith Energy's 41 MW Jundee Hybrid Project in Western Australia.

As in 2023, large-scale solar projects provided the majority of generation capacity added, at 1.3 GW (down on 1.9 GW in 2023). Queensland installed the most new large-scale solar capacity, with three projects totalling 385 MW, having also led the states in 2023. Western Australia commissioned the most projects, with six, with a combined capacity of 238 MW . The largest solar plant was BJEI Australia's 330 MW Wellington North Solar Farm in New South Wales, which is now the third-largest operational solar farm in Australia.

Large- and medium-scale solar now provide 18.1 per cent of renewable energy generated in Australia, up from 15.6 per cent in 2023. They account for 7.2 per cent of all electricity generation, up from 6.2 per cent in 2023.

Wind projects provided 836 MW of new capacity, down on 946 MW in 2024. Six wind farms were connected to the grid in 2024 – one less than 2023. In terms of capacity added, the largest wind farm commissioned in 2024 was Tilt Renewables' 396 MW Rye Park Wind

2 GW

of large-scale generation capacity added in 2024

(2023: 2.8 GW)

1.2 GW

large-scale solar projects completed in 2024

(2023: 1.9 GW)

21

large-scale renewable energy projects completed in 2024

(2023: 22)

8.7 GW/ 23.3 GWh

approximate capacity of large-scale batteries under construction at end of 2024

(2023: 5 GW / 12 GWh)

Farm in New South Wales, which is considerably larger than the largest wind farm commissioned in 2023 (244 MW). New South Wales led the states in 2024 with 541 MW, with Victoria in second at 158 MW. Victoria provided 33.2 per cent of Australia's wind generation in 2024 and remains the wind-generation leader among the states and territories.

There were 59 large-scale renewable energy projects under construction as of December 2024, up from 56 at the same point in 2023. The combined capacity of those projects is approximately 9.9 GW – a marked improvement on the 2023 figure of 7.5 GW. Thirty-nine of those projects are large-scale solar farms (up from 38 in 2023), 18 are wind projects (up from 13 in 2023) and the remaining two are biomass projects.

In 2024, construction commenced on 22 renewable energy projects for a combined 3.6 GW of capacity – a noteworthy improvement on 2.7 GW in 2023. The record for construction commencements in a single year remains 2022, at 5 GW.

Generation investment soars

In 2023, the story of large-scale renewables was increased capacity added but worryingly low levels of new investment commitments. This flowed through to lower levels of generation being commissioned in 2024. Conversely, 2024 saw significantly improved levels of new financial commitments to large-scale generation, particularly in the second half of the year. The $9 billion invested in new generation capacity in 2024 was the highest since the 2018 record, and represents 4.3 GW of new generation capacity.

Thirteen large-scale solar projects reached financial commitment in 2024, for a combined capacity of 1.9 GW – significantly up from seven new commitments in 2023, for 921 MW. The wind sector, meanwhile, bounced back strongly, with eight new financial commitments, up from zero in 2023.[1] Those projects will amount to 2.2 GW of new generation capacity.

Storage still strong

After a record-breaking year for investment in large-scale storage in 2023, 2024 was another very strong year for a sector that is crucial to providing the essential firming capabilities that a grid formed primarily from variable renewable energy sources will need.

Thirty-eight large-scale batteries were under construction at the end of 2024, up from 27 at the end of 2023, which was up from 19 in 2022. The combined capacity of those 38 projects will be 8.7 GW / 23.3 GWh, up from 5 GW / 12 GWh in 2023.

Five utility scale battery storage projects were connected to the grid in 2024, for a combined capacity of 619 MW / 1,677 MWh . The final quarter of 2024 was a record-breaking one, as more than 1 GWh worth of battery projects came online in a single quarter for the first time. Those projects were the Rangebank BESS in Victoria (200 MW / 400 MWh) and the Collie Battery – Stage 1 in Western Australia (219 MW / 877 MWh). The Collie Battery – Stage 1 was also the largest battery in terms of capacity commissioned in 2024.

As of the end of 2024, there is over 8.7 GW / 23.3 GWh of large-scale battery capacity under construction in Australia. That is not only more big battery storage than is currently operational in Australia – it's more than a third of Australia's coal-fired power stations combined.

At $3.7 billion, investment in utility scale batteries is down on the record-breaking $6.9 billion in 2023. It is still a strong number, however, and is most likely significantly higher. Not all projects which reached financial commitment in 2024 had publicly disclosed investment figures at the time of writing. The largest project, by capacity, to be financially committed is Akayska Energy's Orana Battery Energy Storage System, at 415 MW / 1.6 GWh. According to Akaysha Energy, this is the largest investment in a single battery anywhere in the world.

> “The $9 billion invested in new generation capacity in 2024 was the highest since the 2018 record

Other generation sources

Genex Power's 250 MW / 2,000 MWh Kidston Pumped Storage Hydro Project is nearing completion and is likely to be energised in the second half of 2025. When completed, it will be the first new hydropower project in Australia in more than 40 years, and the third-largest electricity storage facility in the country. Two other pumped hydro projects – the Goat Hill Pumped Storage Hydro Project in South Australia and the Snowy 2.0 project in New South Wales – are also under construction, while a range of modernisation projects are also progressing across Tasmania's hydropower fleet.

[1] The Uungula wind farm reached financial close in late 2023 but was not publicly announced until 2024, meaning it was not captured in our 2023 data.

Hydropower provided 13,295 GWh of generation in 2024, down from 15,307 GWh in 2023. It contributed 5.5 per cent of Australia's electricity generation in 2024, down from 6.5 per cent in 2023, and 13.7 per cent of Australia's renewable generation, also down on 2023 (16.4 per cent).

Unfortunately, 2024 also saw the cancellation of the Pioneer-Burdekin Pumped Hydro Project, which would have provided 5 GW / 120 GWh of capacity if delivered. The new Queensland Government cited financial unviability and inadequate community consultation in its reasons for the cancellation.

Bioenergy provided 3.7 per cent of clean energy generated in Australia in 2024, up from 3.5 per cent in 2023, and 1.5 per cent of Australia's total electricity generation, up from 1.4 per cent in 2023. Expectations have been growing for a more favourable policy environment for bioenergy as the Commonwealth considers support options for the development of sovereign production capacity for low-carbon liquid fuels.

> On average across Australia, it takes solar projects six fewer months than wind projects to progress from financial commitment through to the final commissioned stage

Large-scale pipeline

In late 2024, the first tender round for generation under the Capacity Investment Scheme (CIS) was announced. The 19 large-scale projects selected have a combined generation capacity of 6.4 GW, and a storage / generation capacity of 1.2 GW / 3.6 GWh.

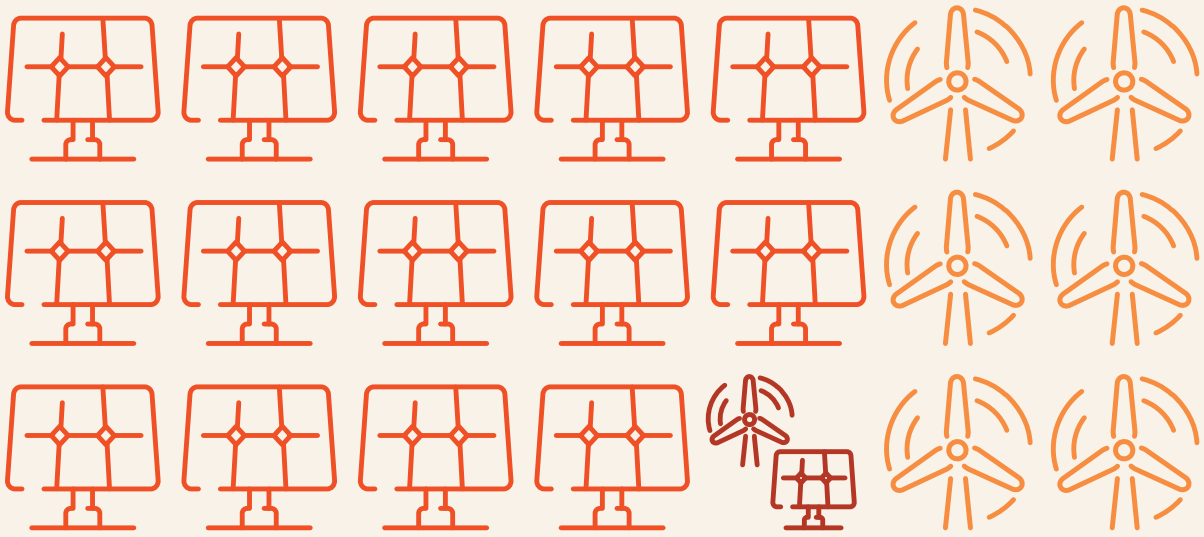
Although large-scale capacity added was down on 2023, the vastly improved investment landscape is cause for positivity, and could help Australia turn its huge pipeline of projects into reality. That would help push large-scale capacity added per year closer to the 6 GW required by the Step Change scenario in the Australian Energy Market Operator's 2024 Integrated System Plan, for meeting net zero targets by 2050.

Rystad Energy expects 2025 to be a record year for new capacity in Australia, with an estimated 7.2 GW coming online. That would include several high-profile projects such as the Kurri Kurri gas plant that will supplement generation at Snowy Hydro, the large-scale batteries at the Eraring and Liddell Power Stations, and a whole host of other renewable energy developments.

Project completion time from financial commitment to commissioning (months)

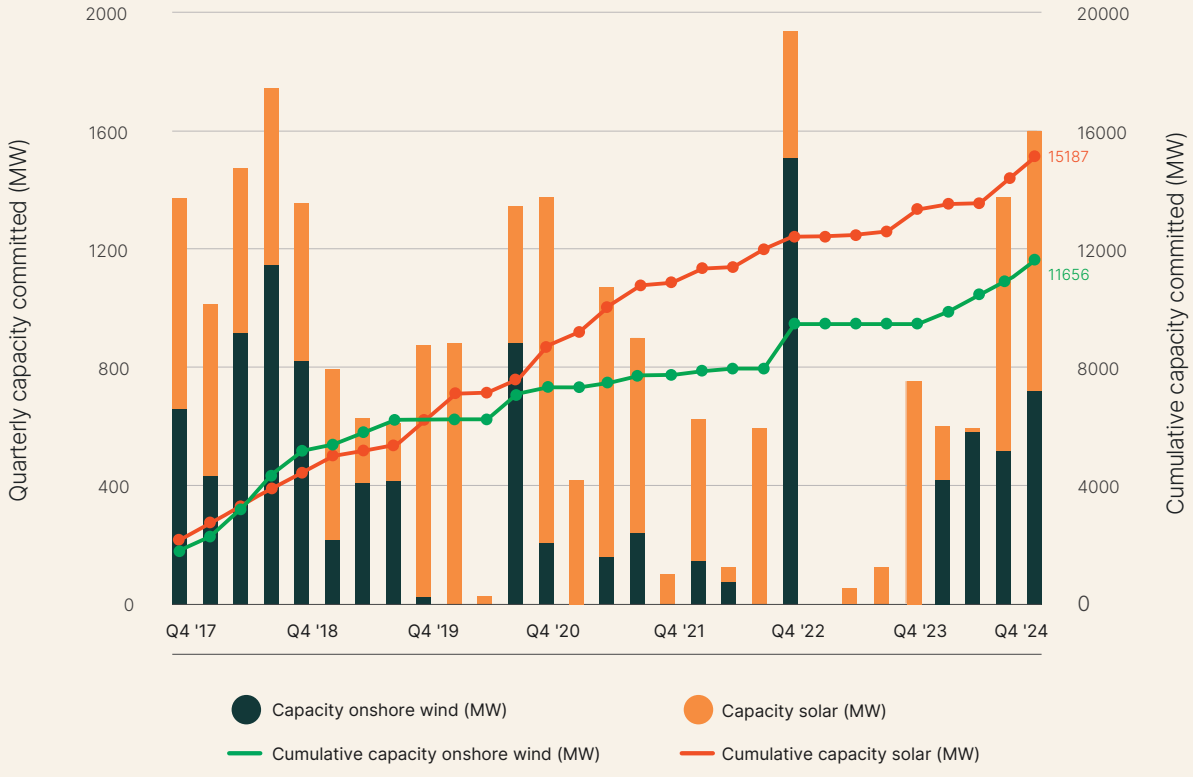
State	Solar	Onshore wind	Battery	Hybrid
VIC	18	26	19	N/A
NSW	20	30	N/A	N/A
QLD	23	N/A	N/A	N/A
SA	17	21	17	N/A
WA	20	N/A	28	14
Total average by tech:	**20**	**26**	**21**	**14**

Large-scale renewable energy generation projects commissioned in 2024



14 solar farms | 1 hybrid solar/wind | 6 wind farms

Cumulative capacity of onshore wind and solar farms that have reached financial close since 2017



World's End Gorge
Burra, SA
Ngadjuri Country
(Neoen)

CASE STUDY

Clean energy creates new national park – Neoen's Goyder South project

As clean energy accelerates across Australia, how do developers ensure their operations are appropriately conducted, and that local groups, including First Nations, are as informed and engaged as possible? Thankfully, as the industry matures and grows, engagement with and respect for First Nations communities is growing too.

One such project is Neoen's Goyder Renewables Zone, a hybrid wind, solar and battery development along Goyder's Line of Rainfall, on Ngadjuri country near the town of Burra, South Australia. The project is split into two sections, Goyder North and Goyder South. The 412 MW Stage 1 of Goyder South is currently under construction and is Neoen's largest wind power asset worldwide.

Neoen has put in place a number of benefit-sharing apparatus in the area, chief among which is the creation of a new national park in South Australia's Mid North, now owned by South Australia's Department of Environment and Water and to be managed in consultation with the Ngadjuri Nation. The park will bring enormous conservation and economic benefits to the region, as well as provide access to a uniquely beautiful location to the local communities.

Parks and reconciliation

The approximately 1,000 hectares of land that constitute Worlds End Gorge are adjacent to the Goyder Renewables Zone and were purchased by Neoen from local landowners. In late 2023, Neoen gifted this land to the South Australian Government to own in perpetuity and manage in consultation with the Ngadjuri Nation. It will be combined with the neighbouring Hopkins Creek Conservation Park to form the new 1,600ha national park at Worlds End Gorge. The project encapsulates what can be achieved with both outside-the-box thinking and genuine and respectful collaboration with Traditional Owners, with benefits that will endure beyond initial consultations or agreements. The national park will be co-named in consultation with Traditional Owners, there will be Aboriginal rangers hired to help maintain the land, and a community reference group will be established, which will include representatives from the Ngadjuri Nation. But most importantly, it means the land will be conserved and protected, and that the Ngadjuri Nation will have a say in the future treatment of their lands.

"We [Neoen] are contributing an annual payment for the 30+ year lifetime of the Goyder South Stage 1 wind farm to support conservation activities and the fulfillment of the land's use as a native vegetation offset," says Tom Jenkins, former State Leader for South Australia and Tasmania at Neoen. "We are interested in developing high-quality projects because they form the basis of our revenue, and we work hard to build a meaningful social license because we become part of the fabric of the community as long-term neighbours. It is reciprocal," says Jenkins. "A supportive host community always means a better, stronger project. We also rely on communities to guide us on the best ways to share benefits from the project, and to help implement those initiatives. Worlds End Gorge would not have been possible without the participation of many stakeholders at the community level."

Bango Wind Farm
Boorowa, NSW
Ngunnawal Country
(Squadron Energy)

POLICY LANDSCAPE

Federal policy

The biggest Federal Budget for clean energy in Australia's history was launched, while energy prices continued to be prominent in the national discourse.

The Federal Budget delivered in 2024 was an historic moment for clean energy in Australia, with significant spending commitments across the sector. Highlights included $6.7 billion over a decade for a Hydrogen Production Tax Credit, which was passed into law later in 2024 as part of the *Future Made in Australia Bill*, in addition to $2 billion for a second round of the Hydrogen Headstart program.

> The 2024 Federal Budget was an historic moment for clean energy in Australia

The significant commitments to the renewable hydrogen sector are aimed at unlocking what could represent huge industrial growth opportunities for Australia across a range of sectors, from green metals to clean fuel production. Australia's abundant natural resources, mineral wealth, and skilled workforce make it a prime contender for a significant renewable hydrogen industry.

Another measure announced in the Budget and subsequently passed into law was $7 billion over 11 years to support a Critical Minerals Production Tax Incentive.

In May 2024, the Treasury released a *National Interest Framework* to guide strategic investment choices as part of the *Future Made in Australia* agenda.

The Budget also made significant commitments to a broad range of areas of the energy transition, including highlighting the importance of building the clean energy workforce that will be needed to build and maintain the huge infrastructure buildout, and acknowledging the crucial importance of consumer energy resources.

See the graphic on page 24 for more details on some of the headline Budget announcements.

Support mechanism

Meanwhile, the Capacity Investment Scheme (CIS), which was extended by the Federal Government in 2023 to incentivise the uptake of more large-scale generation, opened its first tender process for generation in May 2024 – the largest-ever tender for renewable energy in Australia.

The outcome of that first generation round was announced in December 2024,[1] and included 19 projects, which will provide total generation capacity of 6.4 GW. Eight of the selected projects are hybrid projects and will provide combined storage capacity of 3.6 GWh. The new projects include 3.7 GW (900 MWh) for New South Wales, 1.6 GW (1.5 GWh) for Victoria, 574 MW for South Australia, and 550 MW (1.2 GWh) for Queensland.[2]

[1] Australian Energy Market Operator, https://aemoservices.com.au/en/tenders/cis-tender-1-generation-nem
[2] S Macnamara, Energy Magazine, https://www.energymagazine.com.au/cis-tender-1-to-deliver-6-4gw-clean-energy/

2024–25 Federal Budget clean energy highlights

$6.7 bn

over the next decade for a new Hydrogen Production Tax Incentive of $2 per kilogram starting from 2027-28

$2 bn

for a new round of the Hydrogen Headstart program

$7 bn

over 11 years from 2023-24 for a Critical Minerals Production Tax Incentive

$7 bn

over 11 years from 2023-24 for refining and critical mineral processing

$5.1 bn

boost to ARENA to deliver:

- $1.7 bn for the Future Made in Australia Innovation Fund to unlock private capital across new industries like green metals and low-carbon liquid fuels
- $1.5 bn to build capability in solar and battery manufacturing (including Solar Sunshot)
- $1.9 bn to recharge ARENA's core mission developing, commercialising, manufacturing and deploying new renewable energy technologies

$1.4 bn

over 11 years from 2023–24 to support manufacturing of clean energy technologies, including $96.6 million to strengthen environmental approvals for renewable energy, transmission and critical minerals projects, deliver additional regional plans, and undertake targeted scientific studies to improve the environmental data used in decision-making

While there is plenty of time still to go until these projects are built and commissioned, early signs are that the CIS, as the primary Federal mechanism to replace the diminishing incentives of the soon-to-expire Renewable Energy Target, is strengthening investor confidence in large-scale investment and storage projects.

For more on a fantastic year for investment in renewable energy, see the 2024 snapshot on page four.

Energy discourse

In the second half of the year, the energy system came into sharp focus and was at the centre of political discourse as the country moved towards a Federal Election. The question as to what forms of energy were the cheapest, and what shape the energy system should take, were widely discussed.

Modelling by the Commonwealth Scientific and Industrial Research Organisation and others found that clean energy was the lowest-cost replacement for ageing and increasingly unreliable coal-fired power and that nuclear energy, even if it were decreed to be lawful, would take many years to establish in Australia.

Clean Energy Council modelling has confirmed that renewable energy, backed by various forms of energy storage and a minimal and reducing amount of gas, will be the lowest-cost energy future for Australia.

For state-specific policy highlights, go to page 26, and for trends by state, go to page 28.

Zenith Energy's Northern Star Resources Jundee Project Wind Farm (Australia's most remote wind farm). Powered by Goldwind
Northern Goldfields, WA
Tjiwarl Country

State targets and commitments

Key initiatives, targets and updates for Australia's states and territories

New South Wales

- Halve emissions by 2030
- Net-zero by 2050
- NSW Electricity Strategy includes $8 billion of new private investment over the next decade
- Almost 200 large-scale renewable energy projects totalling almost 35,400 MW in the NSW planning system, representing almost $50 billion in investment
- NSW Climate Change (Net Zero Future) Bill passed in December 2023, enshrining the state's energy transition targets into law

Tasmania

- 150 per cent renewable electricity generation by 2030
- 200 per cent renewable electricity generation by 2040
- Has achieved net zero emissions or less nine years in a row

Queensland

- Renewable energy targets including 50 per cent renewable energy by 2030 and 80 per cent by 2035 are scheduled to be scrapped by new QLD Government, but at time of writing remain in place
- Newly elected LNP Government has committed to net zero target by 2050
- Pioneer-Burdekin pumped hydro project has been cancelled

[1] QLD Government, https://statements.qld.gov.au/statements/98416

South Australia

- 100 per cent renewables by 2027, brought forward from 2030
- Net zero emissions by 2050
- Bilateral Renewable Energy Transformation Agreement with the Australian Government commits to building 1 GW of new generation capacity

Victoria

- 65 per cent renewable electricity by 2030 (previously 50 per cent)
- Legislated target of 95 per cent renewable electricity generation by 2035
- Legislated target of at least 6.3 GW of energy storage by 2035
- At least 2 GW of offshore wind generation by 2032 (only state with a legislated offshore wind target)
- Fully decarbonised road and transport sector by 2045

Australian Capital Territory

- 100 per cent renewable energy and net zero by 2045 (including phase-out of fossil fuel gas)
- ACT has run on 100 per cent renewable electricity since 2020
- Integrated Energy Plan was published in 2024 and is set to be reviewed in 2027

Western Australia

- State-owned coal fired power station capacity – the majority of the state's total coal-fired generation – to close by 2030.
- 80 per cent emissions reduction target by 2030
- Bilateral Renewable Energy Transformation Agreement with the Australian Government commits to building 1.1 GW of new storage capacity
- More than $3.8 billion committed to support WA's energy transition
- $22.5 million commitment to help streamline approvals for clean energy proposals

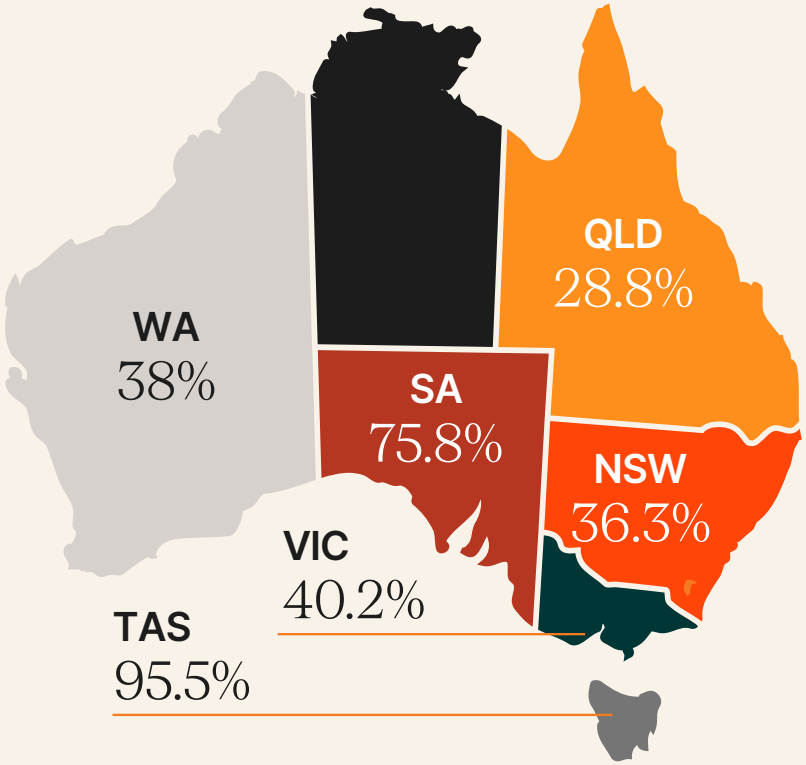
Northern Territory

- 50 per cent renewable electricity generation by 2030
- Net-zero by 2050

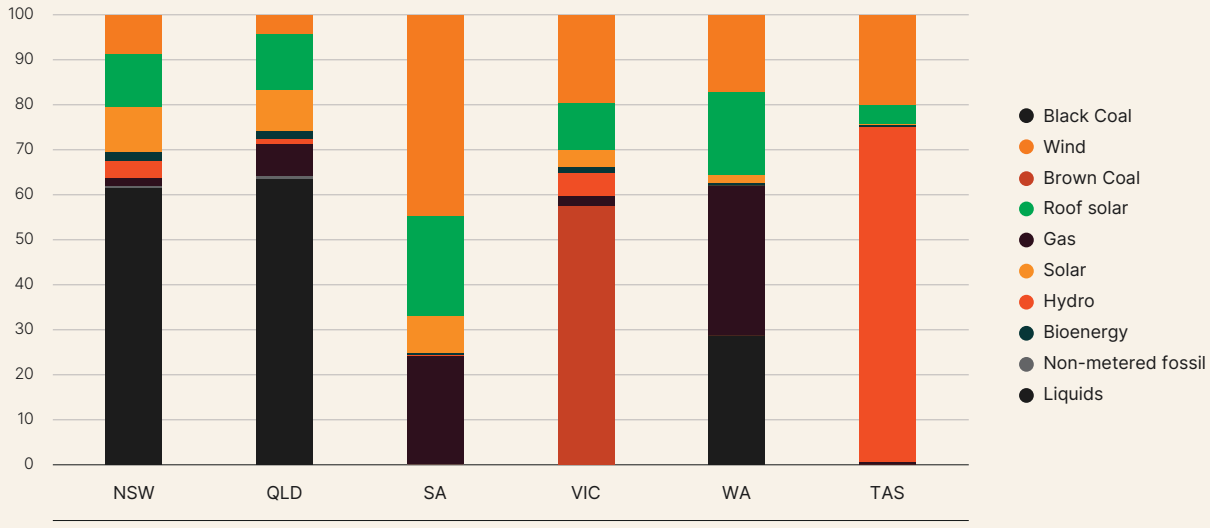
Renewables by state

Renewable energy penetration by state as proportion of generation

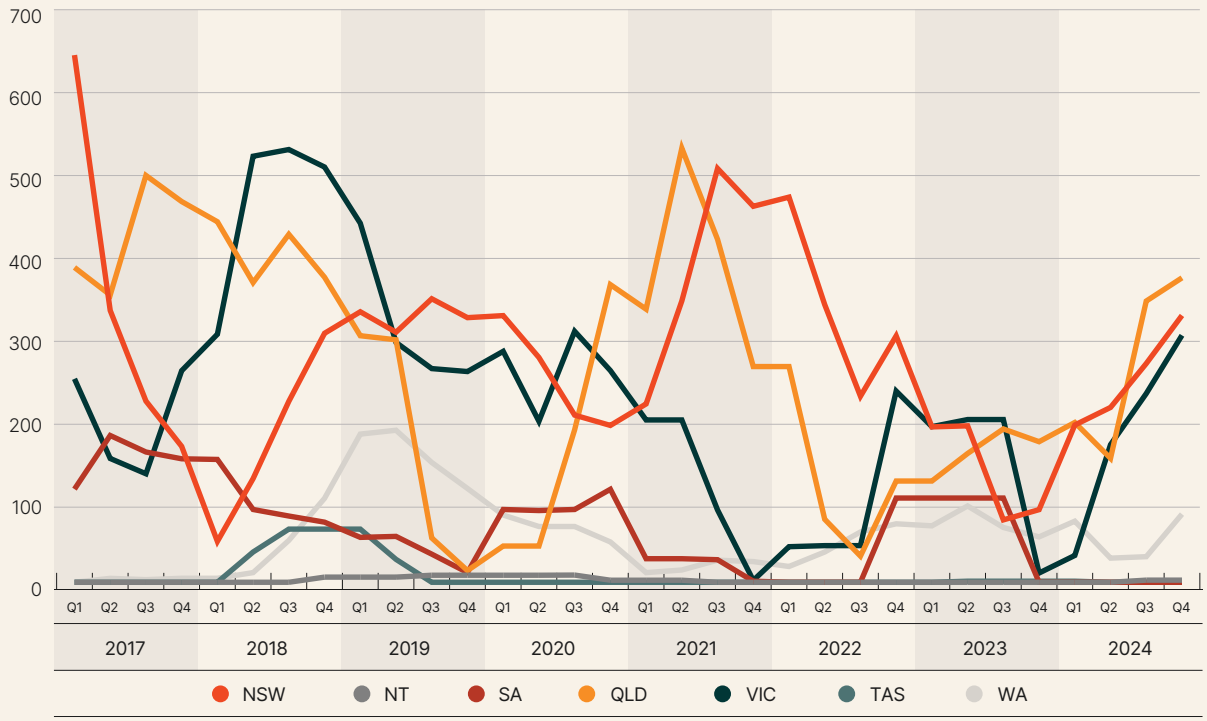
National
40%



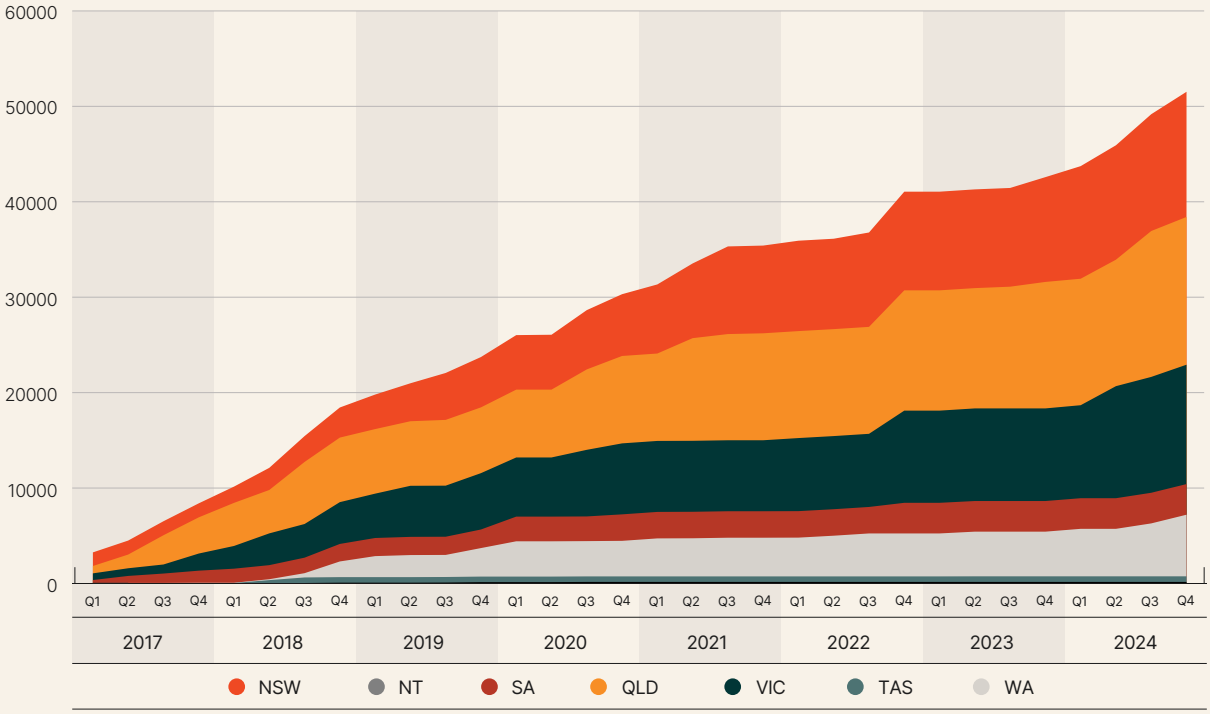
Energy generation distribution by state (%)



Rolling 12-month average of installed capacity (MW) of generation projects by state



Cumulative investment in generation projects by state ($M)



Tropicana Wind Farm
Great Victoria Desert, WA
Wongatha Country
(Pacific Energy)
Pacific Energy's Tropicana wind farm is powered by Goldwind wind turbines

Employment

Governments across Australia are recognising the urgent need to support and grow the clean energy workforce.

The pace and scale of deployment of new clean energy infrastructure must increase markedly towards the end of the decade to ensure ageing coal-fired generation is replaced. Compared with the Australian Energy Market Operator's *2022 Integrated Systems Plan* (ISP), the *2024 ISP* Step Change scenario requires 16.7 GW more utility-scale generation and 11.6 GW of storage capacity by 2030. It also demands a higher annual average rate of deployment and higher peak deployment than the *2022 ISP*.

> The clean energy workforce needs 40,000 more workers by 2030 to support the energy transition

An increased pace and scale of deployment of clean energy infrastructure will have profound impacts on the size of the workforce needed to perform this work. The workforce required for the Step Change scenario in the *2022 ISP* grew from 25,000 workers in 2022 to 33,400 in 2030, an absolute increase of just 8,400 workers. In the *2024 ISP*, the workforce grows from 21,500 workers today to 56,800 in 2030, an absolute increase of 34,300 workers. The ISP figures refer only to the National Electricity Market, with Clean Energy Council research suggesting that nationally, the clean energy workforce needs 40,000 more workers by 2030 to support the energy transition.

Importantly, workforce availability is not an input to the ISP. It assumes that workforces are perfectly elastic, with a sufficient supply of workers when and where they are needed. In consequence, the model allows boom-bust construction cycles. Key to smoothing the build profile and managing these risks is a concerted coordination and planning effort between industry, communities, and governments, at State, Federal and Local levels. State and Federal Governments have recognised the need for higher levels of workforce planning to accommodate this workforce growth.

In 2024, many jurisdictions began consultation on strategies to address the growing demand for clean energy skills. The Federal Government began consultation on the National Energy Workforce Strategy, Victoria continued work on the state's Energy Jobs Plan, and New South Wales engaged with industry on its 2030 Renewable Energy Workforce Plan. Each consultation responded to the challenges documented by Jobs and Skills Australia's landmark *Clean Energy Generation* report (2023) – a report that the Clean Energy Council was closely involved in developing. The Federal Government also launched its First Nations Clean Energy Strategy, which aims to empower First Nations communities to enter equitable partnerships and experience economic benefits, while growing the First Nations clean energy workforce.

Meeting the growing demand for clean energy skills requires a robust and accessible training and education sector. The year saw the release of the final report into the Universities Accord, which made 47 recommendations to improve access to higher education in both tertiary and vocational

education. A new National Skills Agreement between the Commonwealth and states and territories also commenced. The Agreement aims to transform the national Vocational Education and Training system with $3.7 billion in additional funding over five years. Both the Universities Accord and the National Skills Agreement acknowledge and respond to the challenges of attracting and retaining the workforce needed for the net zero transformation. This involves two related problems: improving the visibility of clean energy careers and improving worker retention by enhancing workforce mobility.

To address the visibility gap for young people seeking a career in clean energy, the Clean Energy Council and the Energy Efficiency Council, in partnership with the Queensland Government, held Careers for Net Zero jobs fairs in Toowoomba, Gladstone and Townsville. These events brought together local businesses, workers, industry, peak bodies, government and training and education, to highlight the diverse career opportunities available across the clean economy to over 600 local community members who attended the events.

The Clean Energy Council is working to improve workforce mobility in the clean energy industry by delivering Clean Energy Required Training (CERT) projects in Victoria and Queensland. They will establish consistent, industry-agreed benchmarks on the qualifications required for trade workers employed in the construction, commissioning and operation of onshore wind, solar and battery projects in each state. Both CERT projects will launch for industry in 2025.

Securing a just transition for workers impacted by the transition to net zero is also a core focus of the newly established Commonwealth Net Zero Economy Authority.

Chloe Munro Scholarship for Transformational Leadership 2024 recipients

In recognition of the enormous legacy of the late Chloe Munro AO, the Clean Energy Council and a coalition of organisations established the Chloe Munro Scholarship for Transformational Leadership. The scholarship honours Chloe's legacy and supports the next wave of women leaders. Building on the success of the inaugural 2021 scholarship, there were 10 recipients in 2024.

The scholarship is open to emerging and mid-level women leaders in the fields of renewable energy, energy management and carbon abatement. Successful applicants receive a fully funded scholarship to undertake one of two courses offered by education provider, Women & Leadership Australia.

Megan Aspinall
Director, Infrastructure Advisory (Energy), KPMG

Tori Cannon
Project Development Manager, Aula Energy

Bethany Du
Senior Legal Counsel, RES

Uduak Ekpenyong
Associate, Aurecon

Carla Evans
Senior Development Manager, OX2

Kirsten Lee
Stakeholder, Compliance and Sustainability Manager, Beon Energy

Cindy Ng
Mechanical Engineer, Alinta Energy

Kavya Santhosh
Solar Plant Asset Manager, NovaSource Power

Lucy Sinclair
Senior Community Engagement Member (ANZ), Aquila Clean Energy

Lucinda Walker
Senior Renewable Engineer, DNV Australia






CASE STUDY

‘Women powering change’ campaign

Australia is in the midst of a renewable energy revolution and nearly 40,000 more workers from a wide variety of backgrounds and skillsets are needed by 2030. Over the past months, the Clean Energy Council has been sharing the stories of some of the incredible women who are changing the face of energy, with the aim of inspiring more girls and women to choose a career in clean energy.

For more information, visit:
cleanenergycouncil.org.au/women-powering-change

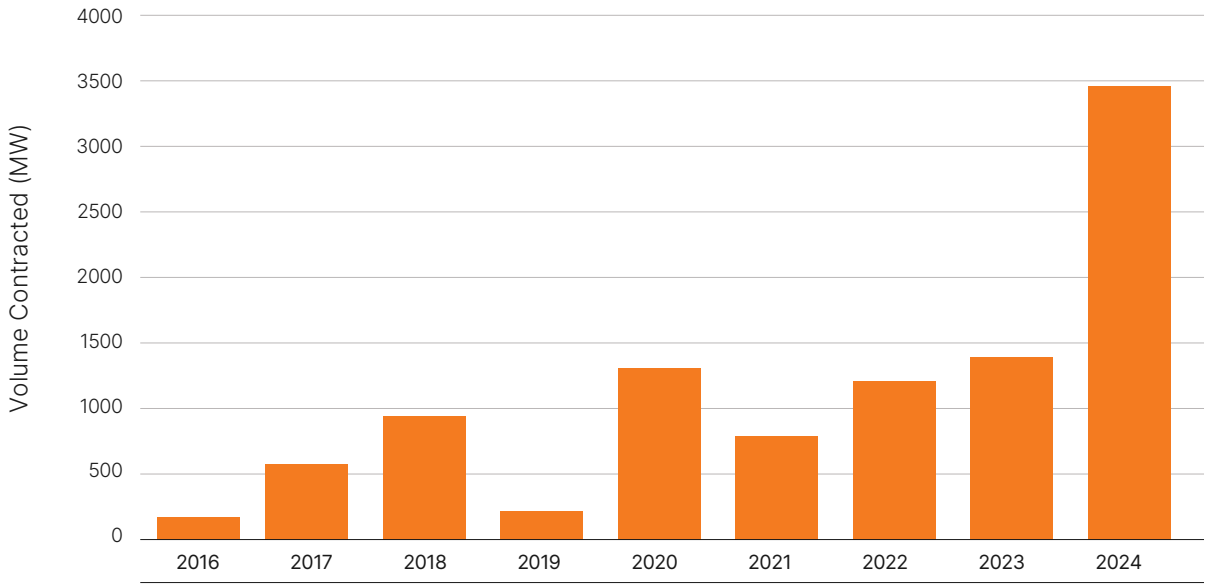
Renewables for business

Corporate Renewable Power Purchase Agreements (PPAs) had another record-breaking year in 2024. For the third year running, the deal volume hit a new record – almost 3.4 GW, which is close to double the record haul of 1.7 GW in 2023.

The record year was headlined by two mega-deals signed by Rio Tinto – a 1,120 MW PPA with Bungaban Wind Farm and a 1,100 MW PPA with Upper Calliope Solar Farm. BHP Mitsubishi Alliance also signed a large-scale PPA in Queensland (296.8 MW) for metallurgical coal production. In what may be a sign of things to come, the resource sector was the biggest player in the PPA market in 2024.

Other large PPAs were signed by repeat buyers IFM & QIC and Telstra (their seventh PPA) and one new entrant (Equinix).

Corporate Renewable Power Purchase Agreements (MW)



Content and data supplied by Business Renewables Centre Australia

The same, but different

Many market participants described the Australian corporate renewables PPA sector in 2023 as a 'sellers' market'. With a slowdown in supply of new renewable energy projects due to a multitude of factors such as transmission constraints, it was often noted there was an excess of demand for PPAs relative to supply.

Many of the same dynamics were at play in 2024 and market participants generally agree there is an excess of buyer demand relative to supply, but there was an element of stasis as more buyers appear to be waiting for market conditions to change.

In the first half of the year, Corporate PPAs were the largest agreement type for new renewable energy capacity and in the second half of the year it was the Capacity Investment Scheme. PPAs signed by retailers remained modest in 2024.

On the supply-side, the volume of renewable energy and storage projects reaching financial close accelerated markedly during 2024. The Australian Energy Regulator is predicting a record volume of renewable energy capacity will be connected to the grid during 2025 and much more capacity is on the way as the Capacity Investment Scheme and Renewable Energy Zones gather pace. Supply is on the way.

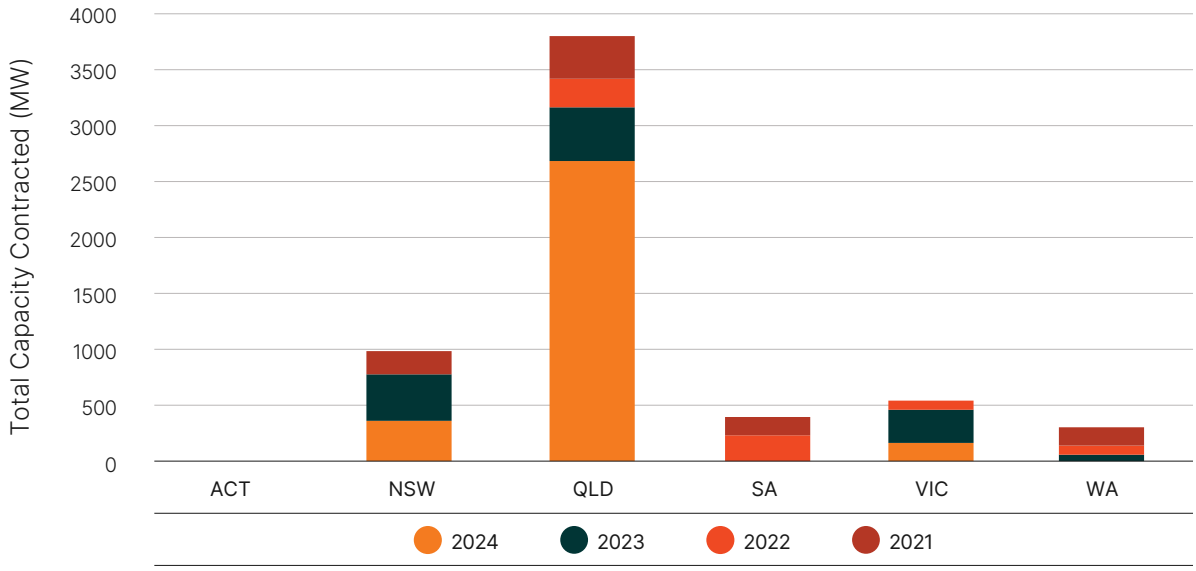
On the demand-side, there were fewer buyers in acute need to contract to meet 2025 targets. Buyers with 2030 targets do not need to contract just yet and some appear to have been waiting for new supply. Higher prices due to elevated supply chain costs also dampened buyer interest in available projects.

While there is a big increase in supply on the way, the supply-demand balance is hard to predict in coming years as there will also be parties with PPAs expiring in 2030 entering the market as well as parties seeking to negotiate new PPAs ahead of 2030 target commitments.

> "In what may be a sign of things to come, the resource sector was the biggest player in the PPA market in 2024.

Queensland has led the states for the last few years and has clearly established itself as the leading state for corporate PPAs. In 2024, over 2.6 GW was contracted in Queensland followed by around 400 MW in NSW.

Corporate PPAs by state



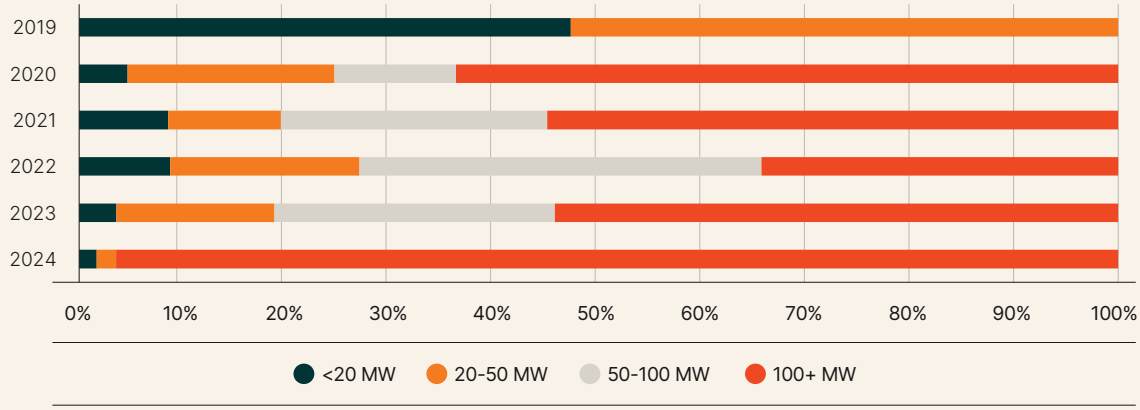
Content and data supplied by Business Renewables Centre Australia

Polarisation in deal size

The most striking feature of the market composition during 2024 was concentration among larger buyers: there was only one 'mid-sized' deal from 20–100 MW.

One of the features of the Australian market has been the diversity in buyer and deal sizes – unlike some overseas markets which are dominated by large buyers. Where small- and mid-sized deals represented a significant portion of the market in past years, large deals accounted for over 95 per cent of capacity announced in 2024.

Corporate PPAs by capacity size (percentage of overall capacity)



The concentration and bifurcation of deal size in the past couple of years may be a product of the supply slowdown and therefore the market will return to greater diversity as the product pipeline improves.

Alternatively, there could be a structural shift towards a larger-buyer market. The cohort of public sector buyers (governments, universities, councils etc) that signed small-to-medium sized PPAs in earlier years who are yet to sign a PPA is certainly diminishing.

With new supply set to flow into the market, the picture on the composition of buyer sizes should become clearer over the next year.

Business Renewables Centre Australia's annual survey has year after year found around two thirds of buyers nominate sustainability targets or policies as the major driver for PPAs ahead of price or financial considerations, regardless of the ups and downs in electricity prices.

The growth in organisations with net zero targets continues to underpin demand for Corporate PPAs. While these non-price factors are most commonly the primary catalyst for interest in PPAs, ongoing price volatility also underlines the financial value of PPAs as a hedge.

The future role of corporate PPAs

The corporate PPA market continues to evolve and reflect the wider dynamics of the energy transition. In the first phase (2016-20), Corporate PPAs were primarily developed by large corporates to leverage greater value and impact from their renewable energy procurement through wholesale PPAs negotiated directly with new projects.

In the second phase (2020-23), corporate PPAs (partly) filled the void after the achievement of the Renewable Energy Target (RET) and the market expanded to a wider diversity of buyers via de-risked PPAs with operational projects brokered by retailers.

Corporate PPAs may be entering a third phase as the post-RET policy architecture is established through the Capacity Investment Scheme, Renewable Energy Zones (REZ) and a new green certificate regime (Renewable Energy Guarantee of Origin, or REGOs) from 2030.

There are three scenarios or trends that could emerge for corporate PPAs under this emerging policy framework. The stasis in the 2024 corporate PPA market and time required for the Capacity Investment Scheme (CIS) and REZs to get into gear means it is still unclear which of these scenarios or trends might dominate, but market participants see evidence of all three in practice.

1. Focus on Capacity Investment Scheme

Since the emergence of Corporate PPAs, there has been a view in some circles that Corporate PPAs are a passing trend that will decline once the major retailers or governments seriously return to contracting with large-scale renewable energy projects. Under this scenario, Corporate PPAs reduce in number as

Content and data supplied by Business Renewables Centre Australia

retailers and project developers focus on bidding for contracts under the CIS.

Demand for Corporate PPAs is underpinned by emissions reduction, Environmental, Social and Governance factors and reputational drivers that will continue, so there will continue to be a significant cohort of buyers seeking PPAs. The large PPAs signed by buyers such as Rio Tinto and BHP also demonstrate that large buyers are likely to see value in negotiating directly with projects outside the CIS.

2. Corporate PPAs are incorporated into Capacity Investment Scheme bids and continue to support new projects

While scenario 1 reflects the decision of bidders that negotiating Corporate PPAs is not worth the time and resources in the context of complex bidding rounds, there are reasons why both projects and buyers could decide to incorporate Corporate PPAs into bids for contracts under the Capacity Investment Scheme.

For project developers, tender criteria encourage and reward bidders with alternative contracts such as Corporate PPAs because the aim is not to displace conventional market contracting. Brad Hopkins (AEMO Services) noted after the announcement of the second round of New South Wales Long-Term Energy Service Agreements (November 2023) that Corporate PPAs were being incorporated into bids and enabling them to reduce the tenure and price terms being sought.

For buyers that are seeking higher standards of additionality – or seeking recognition under voluntary schemes that require contracting before financial closure – negotiating a PPA with a project before being awarded a contract is desirable or even essential. A senior lawyer from one of the major firms in Corporate PPAs observed they have seen some buyers seeking to conclude agreements before CIS tender decisions for these reasons.

There is little information available to assess how common this is as a practice. AEMO Services does not release any information on inclusion of Corporate PPAs and there is only anecdotal evidence on what buyers are doing.

3. Growth in Retailer PPAs and a declining role for Corporate PPAs in underwriting new projects

The experiences of Queensland highlight the role of Corporate PPAs could increasingly be on the other side of financial closure after projects secure contracts through the CIS. In Queensland, state-owned utilities with mandates to sign PPAs have been a key vehicle for contracting with new projects. Until this year, most (but not all) Corporate PPAs have been retail PPAs signed with solar and wind farms that are in commissioning or operational after one of the state-owned utilities have signed a PPA to underwrite construction. A similar dynamic could emerge as the CIS scales up.

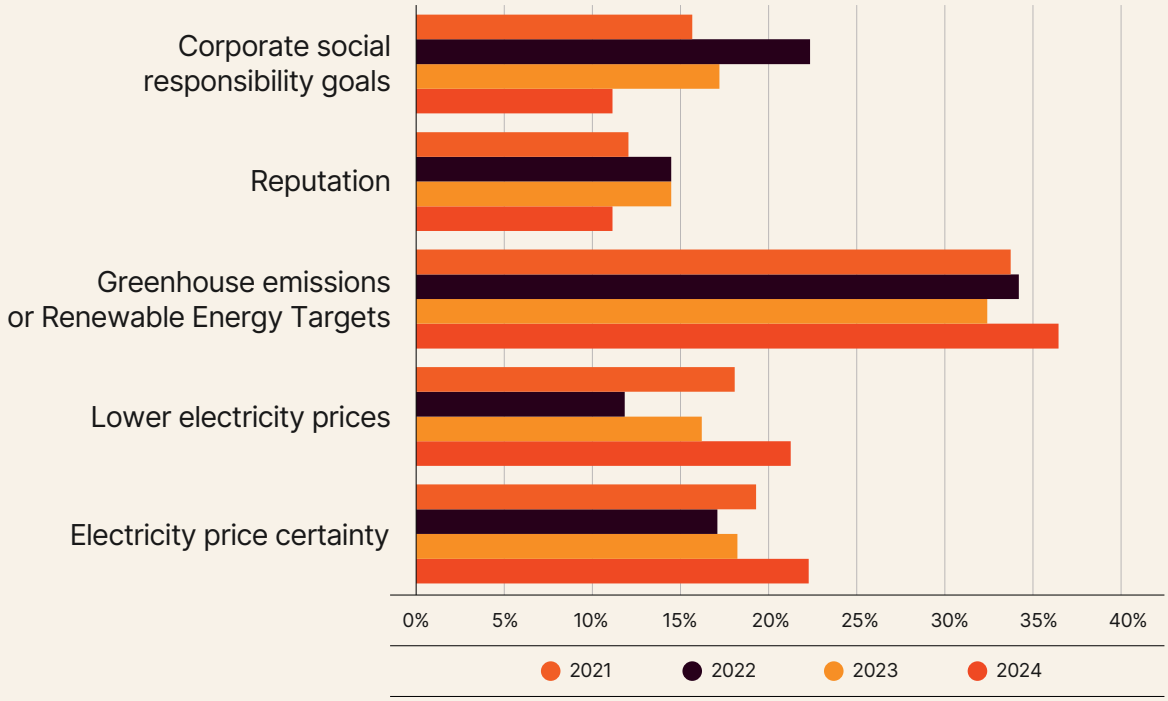
> In the first half of the year, corporate PPAs accounted for most of the new renewable energy capacity and in the second half of the year it was the Capacity Investment Scheme

It may be that the role and composition of Corporate PPAs changes more than the volume. The scale of investment required adds confidence that offtake demand from Corporate PPA buyers will continue to have a role. Corporate PPAs may be negotiated by large counter-parties outside the CIS and sometimes as part of bids through the CIS but remain the minority as in recent years – and the role of PPAs increasingly centres on revenue certainty through commissioning and operational phases. The shift towards more PPAs signed with commissioned and operating PPAs could be consolidated as the big retailers re-enter the market and negotiate PPAs after securing a contract through the CIS.

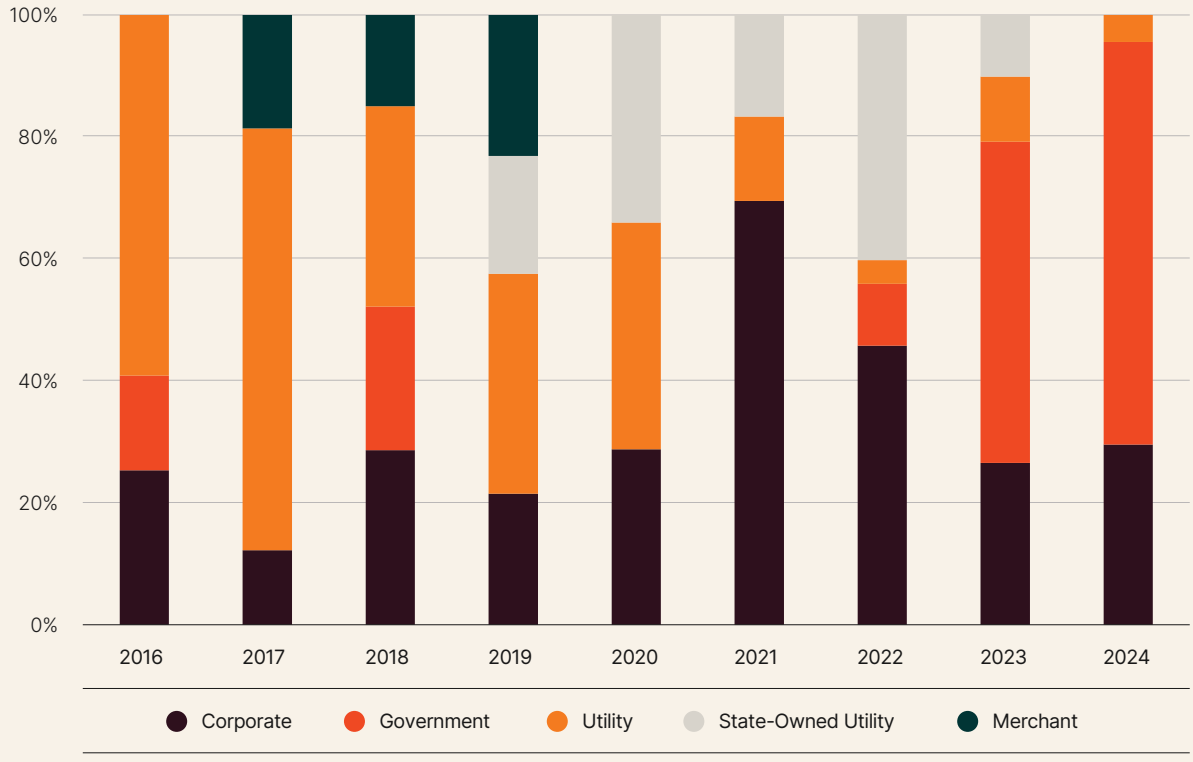
About Business Renewables Centre Australia (BRC-A)
This article was prepared by the Business Renewables Centre Australia. BRC-A is an independent, not-for-profit initiative providing renewable energy procurement guidance, education and resources to Australian businesses seeking to decarbonise and to invest in Australian renewable energy projects. This summary is drawn from the annual State of the Market report produced by the BRC-A on Corporate PPAs. For more on the BRC-A, visit https://businessrenewables.org.au.

About the author
Dr Chris Briggs is Technical Director at the BRC-A and Research Director and Program Lead for the Energy Futures team at the Institute for Sustainable Futures. Chris specialises in energy policy and has over 25 years of experience in policy, research and advocacy, working in Federal, State and City Governments, as well as the non-government and university sectors.

What is the primary driver for your interest in Corporate Renewable PPAs



Power Purchase Agreements by segment, 2016-24



Content and data supplied by Business Renewables Centre Australia

Electricity prices

Energy prices fell year-on-year in 2024 and are predicted to continue to fall, if the renewables rollout continues.

In response to ongoing concerns about energy affordability, the Federal Government introduced measures such as a one-off $300 energy bill credit for every Australian household in May 2024. These initiatives aimed to alleviate the financial burden on consumers amid fluctuating electricity prices.

As a result of the bill relief, the Australian Bureau of Statistics reports that electricity prices fell 9.9 per cent in the final quarter of 2024, and 25.2 per cent in the past 12 months. It concludes that "the introduction of the 2024-25 Commonwealth Energy Bill Relief Fund rebates from July 2024 were the main driver for the fall in electricity prices [in the final quarter of 2024]."[1]

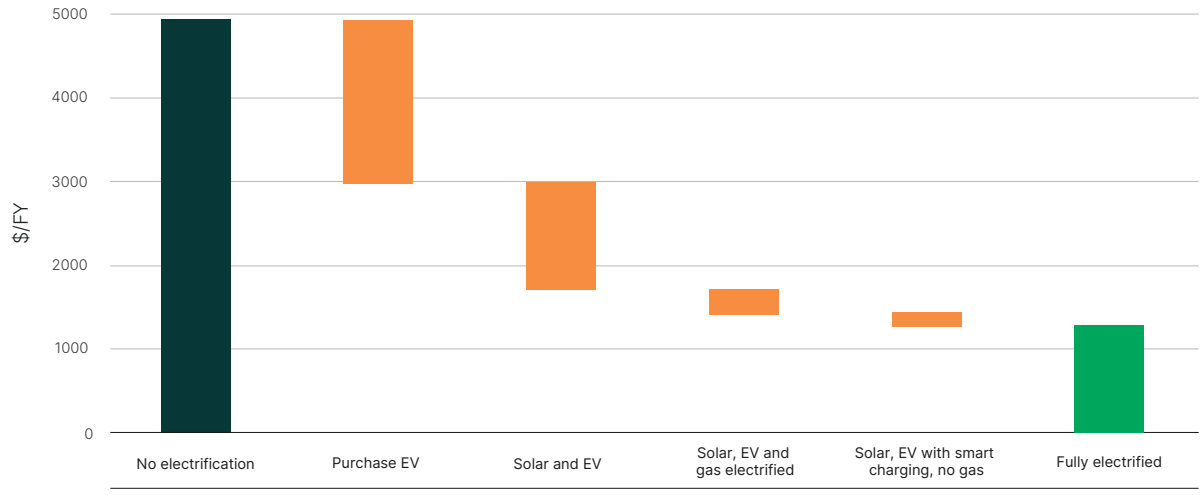
According to the Australian Competition and Consumer Commission, in 2024, Australia's residential electricity prices experienced a notable decrease, with calculated annual prices falling by an average of 4 per cent across regions including New South Wales, Victoria, South Australia, and South East Queensland. Victoria saw the most significant reduction, with prices decreasing by 7.5%.[2]

In its report, *Residential Electricity Price Trends 2024* (published in November 2024), the Australian Energy Market Commission (AEMC) forecasts that energy prices will fall over the next decade, "if investment is efficient and policy well-coordinated".[3]

That decrease could be as much as 13 per cent if several factors are maintained or improved. The

Typical energy cost savings if a household electrified today

(Household with annual electricity consumption of 3,900 kWh)



Source: Institute for Energy Economics and Financial Analysis

[1] Australian Bureau of Statistics, *Consumer Price Index, December Quarter 2024*
[2] Australian Competition and Consumer Commission, *Inquiry into the National Electricity Market, December 2024*
[3] Australian Energy Market Commission, *Residential Electricity Prices Trends 2024*

> Accelerating the uptake of renewables and reducing reliance on fossil-fuel generation is the pathway to cheaper energy bills in Australia

AEMC predicts, for instance, that electrification will reduce household energy costs, and that homes with consumer energy resources (rooftop solar, batteries and other small-scale home energy technologies) will benefit the most. It also notes that "delaying the connection of renewable generation and transmission... would put upward pressure on residential electricity costs".

In the AEMC's forecasting, delays to wind and transmission buildout caused the most significant price impacts, with sub-optimal orchestration of consumer energy resources the second-most impactful factor.

The Clean Energy Council's own modelling reveals that if the buildout of renewables is restricted, and 49 GW of capacity is added by 2030 (compared to 72.7 GW in the Australian Energy Market Operator's Step Change scenario), then retail bills for consumers and small businesses will increase by 30-41 per cent in 2030, or $449-606 per annum per household/business. This is primarily because there will be a greater reliance on higher-cost energy generation sources such as coal and gas.

Volatility remains in wholesale markets

The wholesale price is important to retail electricity prices because it reflects the cost of sourcing electricity and makes up around 35-45 per cent of the total consumer bill, depending on the state, the retailer and market conditions over time. Changes in wholesale prices typically lead to changes in the prices that consumers pay for electricity. Retailers take these costs into account when setting their prices to cover procurement, operational costs, and margin.

Rystad Energy highlights that the volatility of Australian wholesale electricity prices is among the highest in the world, due to a variety of factors including transmission capacity, risk of unplanned outages, and the daily juxtaposition of low daytime prices and high evening prices.

But volatility is not necessarily a negative factor – in fact, it may be partially responsible for the outstanding uptake of battery storage in Australia. Woods Mackenzie reports that "investments in battery storage ... are increasingly profitable due to higher power price volatility and changing market dynamics", particularly as significant amounts of coal generation are retired from the grid.

For more on battery storage, turn to page 55.

Gas plays a crucial role in setting wholesale electricity prices in the National Electricity Market (NEM) because it is often the marginal generator, meaning its cost can determine the price for the entire market when it is needed to meet demand. Rystad points out that the price of gas in Australia "is a function of both domestic and international markets, and thus a wildcard for volatility in Australia's NEM."

This would suggest that while some gas will be needed as a backup to ensure the NEM remains resilient during extreme events, the minimum amount possible would be the best solution for energy bills.

Meeting energy demand

According to the Australian Energy Market Operator, the NEM experienced record-breaking demand levels in 2024, with a new December quarter maximum demand record of 33,716 megawatts (MW) and an average quarterly total demand record of 23,737 MW, a 2.4 per cent year-on-year increase. This was predominately driven by higher temperatures and a growing electrification shift from gas to electricity.[4]

Rooftop solar and grid-scale solar reached new output records in Q4 2024, increasing by 18 per cent and 9 per cent respectively – a surge which led to minimum demand records across many states and territories5. During that period, "renewable energy supplied a record 46 per cent of electricity, driving emissions to record low levels".

Renewable energy is widely regarded as the least-cost pathway to meeting growing electricity demand in Australia. As the cost of renewable technologies, particularly solar and wind, continues to decline, they have become more competitively priced than traditional fossil fuels like coal and gas. These energy sources are not only cheaper to deploy and operate but also provide long-term price stability, as their fuel (sunlight and wind) is free.

The transition to renewable energy helps reduce reliance on volatile fuel prices, such as gas, which can significantly impact electricity costs during periods of high demand. With the increasing integration of renewable energy into the grid, the need for expensive backup generation from fossil fuels diminishes, helping to lower overall system costs.

Accelerating the uptake of renewables and reducing reliance on fossil-fuel generation is the pathway to cheaper electricity bills in Australia.

[4] AEMO | National Electricity Market hits new demand and renewable energy records in December quarter: https://aemo.com.au/newsroom/media-release/national-electricity-market-hits-new-demand-and-renewable-energy-records-in-december-quarter

Transmission

With lots of new transmission needed to support the clean energy transition, and ageing transmission infrastructure to be upgraded or replaced, there was plenty happening in 2024 in terms of regulation and new technological solutions.

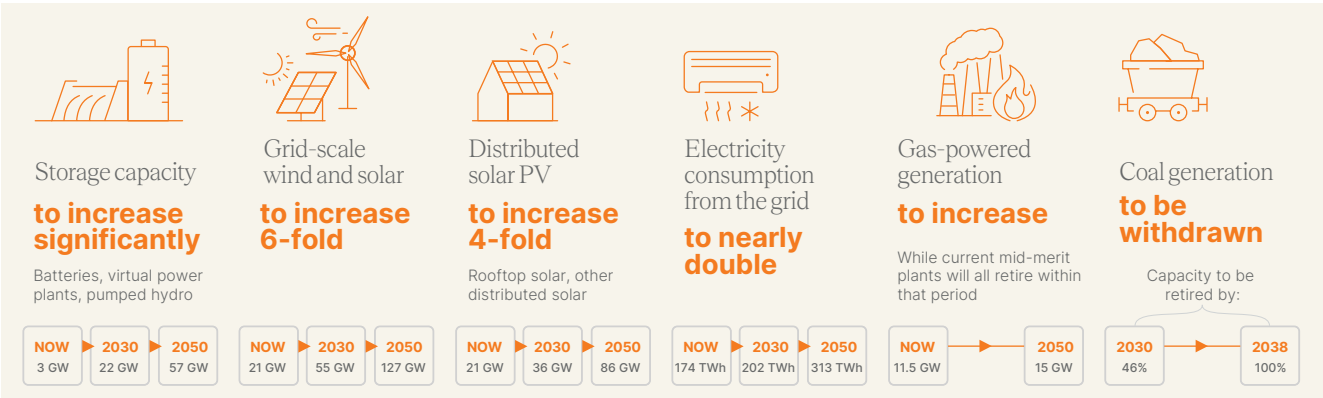
In late June 2024, the Australian Energy Market Operator (AEMO) published the 2024 Integrated System Plan (ISP). Broadly, transmission buildout remains the same as previous ISPs, with no major changes to the timing of projects. Both AEMO's Step Change and Progressive Change scenarios require 5,000 km of transmission in the next decade – creating around 4,000 km of new transmission corridors and upgrading 1,000 km of existing lines, and a total of 10,000 km by 2050.

The only change in relation to the 2022 ISP is the inclusion of seven new actionable transmission projects:

- **Hunter-Central Coast REZ network infrastructure project;**
- **Sydney Ring South;**
- **Gladstone grid reinforcement:**
- **Mid North South Australia REZ expansion:**
- **Waddamana to Palmerston transfer capability upgrade:**
- **Queensland Supergrid South, and**
- **Queensland – New South Wales Interconnector (QNI Connect).**

Combined, these projects will provide the other half of the 5,000 km of transmission network needed over the next decade with full capacity expected to be delivered by early 2033.[1]

According to AEMO, the energy transition requires significant investment to deliver on a six-fold increase in utility scale renewable generation, supported by a 16-fold increase in storage capacity. Much of the required generation and dispatchable capacity will be coordinated in renewable energy zones (REZs)[2] although there are still significant opportunities for new project development in the open network outside of REZs.



Source: Australian Energy Market Operator, 2024 Integrated System Plan

[1] Australian Energy Market Operator (AEMO), *2024 Integrated System Plan, p56*
[2] AEMO), 2024 Integrated System Plan, p52-54

The transmission projects underway will support the expected growth in generation and increase in electricity consumption, particularly from emerging loads such as data centres and electrolysers.

Progression of ISP actionable transmission corridors

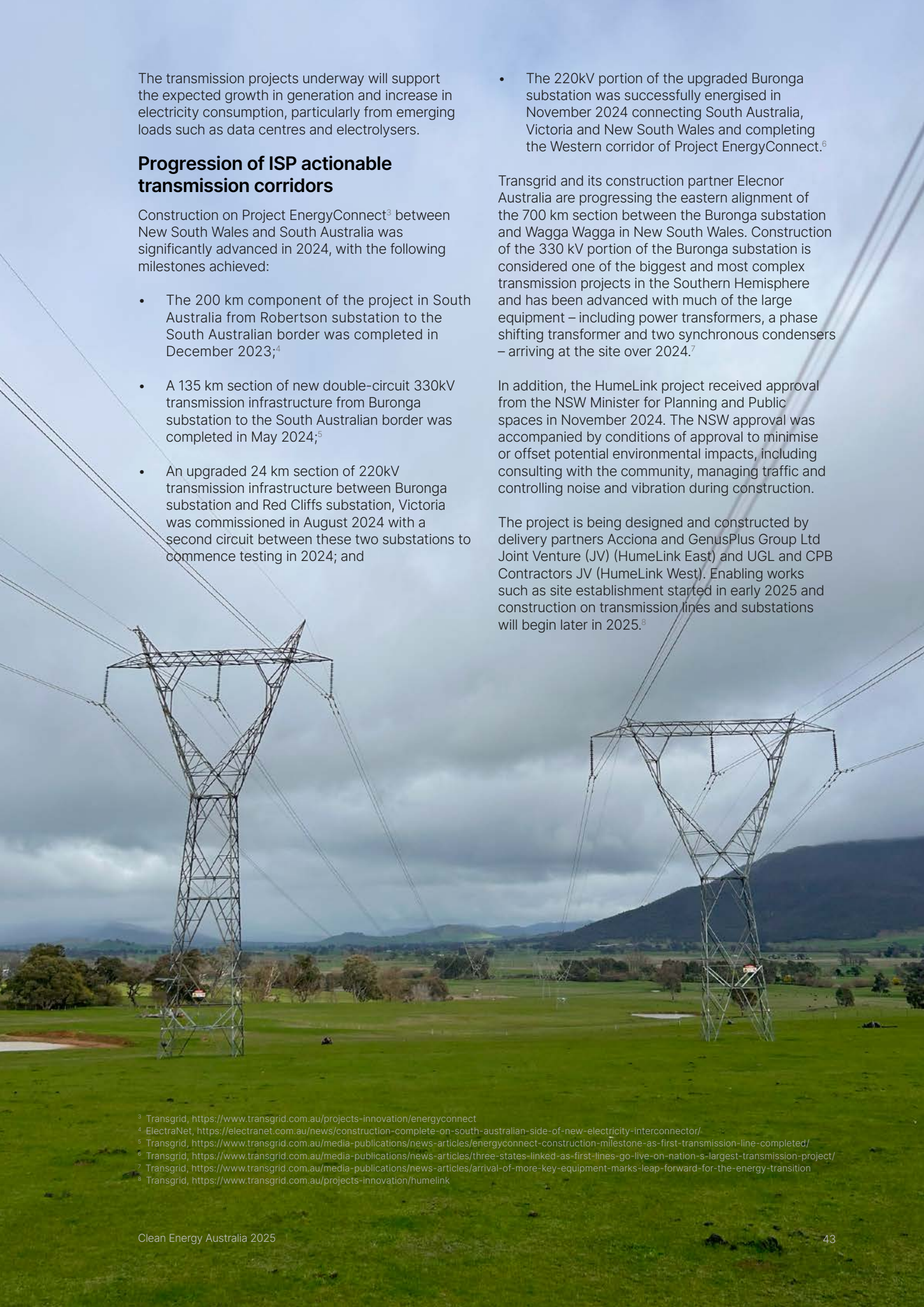
Construction on Project EnergyConnect[3] between New South Wales and South Australia was significantly advanced in 2024, with the following milestones achieved:

- The 200 km component of the project in South Australia from Robertson substation to the South Australian border was completed in December 2023;[4]
- A 135 km section of new double-circuit 330kV transmission infrastructure from Buronga substation to the South Australian border was completed in May 2024;[5]
- An upgraded 24 km section of 220kV transmission infrastructure between Buronga substation and Red Cliffs substation, Victoria was commissioned in August 2024 with a second circuit between these two substations to commence testing in 2024; and
- The 220kV portion of the upgraded Buronga substation was successfully energised in November 2024 connecting South Australia, Victoria and New South Wales and completing the Western corridor of Project EnergyConnect.[6]

Transgrid and its construction partner Elecnor Australia are progressing the eastern alignment of the 700 km section between the Buronga substation and Wagga Wagga in New South Wales. Construction of the 330 kV portion of the Buronga substation is considered one of the biggest and most complex transmission projects in the Southern Hemisphere and has been advanced with much of the large equipment – including power transformers, a phase shifting transformer and two synchronous condensers – arriving at the site over 2024.[7]

In addition, the HumeLink project received approval from the NSW Minister for Planning and Public spaces in November 2024. The NSW approval was accompanied by conditions of approval to minimise or offset potential environmental impacts, including consulting with the community, managing traffic and controlling noise and vibration during construction.

The project is being designed and constructed by delivery partners Acciona and GenusPlus Group Ltd Joint Venture (JV) (HumeLink East) and UGL and CPB Contractors JV (HumeLink West). Enabling works such as site establishment started in early 2025 and construction on transmission lines and substations will begin later in 2025.[8]



[3] Transgrid, https://www.transgrid.com.au/projects-innovation/energyconnect
[4] ElectraNet, https://electranet.com.au/news/construction-complete-on-south-australian-side-of-new-electricity-interconnector/
[5] Transgrid, https://www.transgrid.com.au/media-publications/news-articles/energyconnect-construction-milestone-as-first-transmission-line-completed/
[6] Transgrid, https://www.transgrid.com.au/media-publications/news-articles/three-states-linked-as-first-lines-go-live-on-nation-s-largest-transmission-project/
[7] Transgrid, https://www.transgrid.com.au/media-publications/news-articles/arrival-of-more-key-equipment-marks-leap-forward-for-the-energy-transition
[8] Transgrid, https://www.transgrid.com.au/projects-innovation/humelink

Renewable energy zones

In New South Wales, EnergyCo released a call for registrations of interest to invite interested parties to submit a registration to participate further in the network operator procurement process for a future network operator to design, construct, finance, operate and maintain the New England REZ network infrastructure. [9] Furthermore, in April 2025, EnergyCo appointed ACEREZ – a consortium of Acciona, Cobra and Endeavour Energy – to design, build and finance the Central-West Orana REZ transmission project and operate and maintain it for the next 35 years. The Central West Orana REZ was the first declared REZ in Australia, with the project expected to deliver at least 4.5 GW of new network capacity by 2028 and enable the connection of 7.7 GW of wind and solar projects.[10]

In Queensland, Queensland Treasury released the Draft Renewables Regulatory Framework – Supporting strong and sustainable energy communities in December 2024. As part of this process the Queensland Government is undertaking REZ Readiness Assessments to support the early planning and potential declaration of future REZ developments.

These assessments focus on the potential pipeline of renewable energy development in an area to identify local and regional opportunities and mitigations for cumulative impacts of future REZ development. The assessments are informed by community input, considering a range of social, economic, community and environment matters, including biodiversity, cultural heritage, waste management and land-use planning.[11]

The Queensland Government announced in April 2025 that it would leverage the infrastructure expertise of the Queensland Investment Corporation (QIC) coupled with Powerlink's transmission expertise to prioritise the construction of the Eastern Link (Hughenden Hub to Townsville) of the CopperString transmission project. This will more readily allow the connection of renewable generation in the proposed Flinders Renewable Energy Zone, with QIC to develop options to deliver the best economic value for the Western Link (Hughenden Hub to Mount Isa) at a later date.[12]

In Victoria, VicGrid is in the process of defining the proposed access regime for gird-scale renewable energy generation and battery energy storage systems connecting outside of renewable energy zones. The proposed Grid Impact Assessment released for consultation was the first policy setting document to change the access regime in the NEM and attracted significant interest from renewable energy project developers. VicGrid is continuing to work with industry to develop a regime that better meets the policy drivers it is seeking to address with a view to maintaining an investment environment conducive to bringing on the volumes of new generation capacity needed to maintain reliability and keep energy prices down for consumers.[13]

The South Australian Government sought stakeholder feedback on two new proposed release areas to develop large-scale renewable energy projects under the Hydrogen and Renewable Energy Act 2023. These consist of an approximate 5,200 km2 area on the Upper Eyre Peninsula, termed the Gawler Ranges East proposed release area and a 6,500 km2 area in the Upper Spencer Gulf region termed the Whyalla West proposed release area.[14] These two areas are located within the Eastern Eyre Peninsula and Northern SA renewable energy zones. Once a release area is declared, renewable energy companies will submit competitive tenders to develop projects on the land.

[9] EnergyCo, https://www.energyco.nsw.gov.au/ne
[10] EnergyCo, https://www.energyco.nsw.gov.au/news/deal-sealed-australias-first-renewable-energy-zone
[11] Queensland Treasury, https://www.epw.qld.gov.au/__data/assets/pdf_file/0023/70457/Att-3-Draft-Renewables-Regulatory-Framework-Discussion-Paper-240924.pdf
[12] Queensland Government, https://statements.qld.gov.au/statements/102354
[13] VicGrid, https://engage.vic.gov.au/grid-impact-assessment
[14] Government of South Australia, *Energy and Mining - Release areas – Hydrogen and Renewable Energy Act*

Energy reliability

Australia's power systems and electricity markets are undergoing a once in a lifetime transition to renewable energy. Maintaining the pace of the that transition is the best way to maintain reliability of supply for consumers.

The Australian Energy Market Operator (AEMO), in its latest *Electricity Statement of Opportunities* (ESOO) report, forecasts that "the timely delivery of expected investments in generation, storage and transmission is critical to maintaining reliability for electricity consumers".[1]

For more on a significant wave of investment in the battery storage sector, see page 57.

Crucially, the ESOO predicts that if delivered on time and in full, Federal and State Government plans (that were in place in August 2024) "would provide sufficient generation capacity to meet growing electricity demand within relevant reliability standards over most of the next 10 years". AEMO also find that the energy transition will "result in a significant need for new assets and providers of these essential system services, including for system strength, frequency management, voltage control, ramping capability and system restart services".

The timing and magnitude of those factors are influenced by, among other things, retiring thermal generation, increases in inverter-based resources development, major network augmentations, and installation of consumer energy resources.

However, the ESOO does find reliability risks remaining, if there are delays in renewable buildout. Reliability risks deemed higher than the relevant reliability standards (noting that there are two standards, the interim reliability measure and the Reliability Standard) over the period include the following events: Victoria, in 2027-28 and from 2028-29 after Yallourn Power Station is advised to retire; New South Wales in 2027-28 when Eraring Power Station is advised to retire; and South Australia in 2026-27 when Torrens Island B and Osborne Power Stations are advised to retire.

> "Maintaining the pace in connecting and energising new renewables is critical to maintaining energy reliability

AEMO's ESOO assessment highlights the importance of maintaining the pace in connecting and energising new renewables to maintain reliability. This is reinforced by analysis from Rystad Energy, which shows that pumped hydro and a small amount of gas generation will also play a role.

The reliability outlook in AEMO's 2024 report is nevertheless improved from the previous year and AEMO highlights several reasons for this: the capacity of renewable energy and gas

[1] Australian Energy Market Operator, *Electricity Statement of Opportunities 2024*

developments progressing through the system; consumer investment in larger rooftop solar systems; the extension of the Eraring Power Station; the development of the HumeLink project; and lower projected growth in energy consumption and maximum demand in most National Electricity Market regions than was previously forecast.

Backstop mechanisms

Another form of essential energy reliability protection is emergency backstop mechanisms. As more and more rooftop solar generation enters the system across Australia, the need for these mechanisms has grown. They ensure that for short periods, networks are able to remotely disconnect or prevent export from solar systems to maintain energy security and prevent load emergencies.

Emergency backstop mechanisms have now been introduced in South Australia, Western Australia, Queensland and most recently Victoria in October 2024. These provide an important means for ensuring the electricity grid remains stable under minimum demand conditions. As of early 2025, NSW has initiated consultation to introduce an emergency backstop mechanism for Spring 2025.

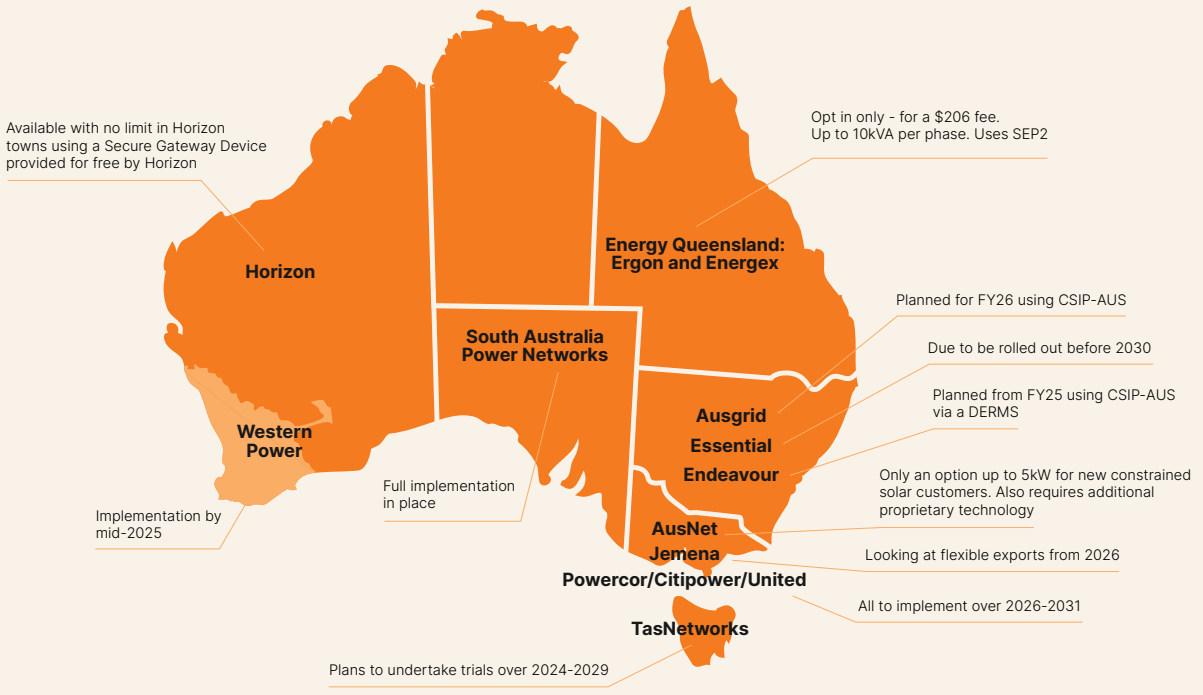
There are actions to increase operational load, such as the widespread installation of orchestrated home battery systems and hot water load shifting, that reduce the likelihood of minimum system load events and can be enacted with minor disruption to consumers. These measures incentivise and reward customers for better utilising their energy and supporting the system and should be used to manage minimum demand reliability prior to an emergency backstop. Emergency backstops should always remain a last resort option to system reliability.

Flexible export limits provide another opportunity to address minimum demand conditions and generate greater value on their investment for customers. Flexible export limits give customers the option of an upper and lower limit on the amount of rooftop solar that can be exported back into the grid and encourage a better use of the distribution system, lowering costs for all consumers.

Compared to a static export limit that has a fixed maximum regardless of system size, customers with a flexible export limit have the potential to provide more solar into the energy system when demand is high. Alternatively, distribution network service providers can actively monitor congestion in the system and reduce rooftop solar exports to avoid a minimum system load event, preventing an escalation of measures to the Emergency Backstop Mechanism.

The introduction and implementation of flexible export limits varies across Australia depending on distribution network service providers. See the map for more information.

Distribution network service providers (DNSP) and the status of flexible exports implementation



Source: Institute for Energy Economics and Financial Analysis

International update

With elections taking place in many countries, 2024 was a pivotal year for the international energy transition.

Global annual renewable energy capacity additions in 2024 were likely around 666 GW, according to forecasting by the International Energy Agency (IEA), which published analysis of the global renewables sector and forecasts to 2030 in its *Renewables 2024*[1] report. That would represent significant growth from the already impressive figures from 2023, when renewable capacity added increased by almost 50 per cent to around 510 GW, which represented the fastest growth in two decades.

The IEA's forecasting predicts that renewable capacity additions by 2030 could be around 935 GW, with solar and wind providing 95 per cent of that mix.

The report also suggests that "at least 1,650 GW of renewable capacity is currently in advanced stages of development and waiting for a grid connection", which is an extraordinary figure and confirms that issues with progressing projects to completion and commissioning is a worldwide problem.

According to Ember's Global Electricity Review 2024, renewables generated a record 30 per cent of global electricity in 2023, although global electricity demand increased by 2.2 per cent, and fossil fuels were used to meet the shortfall. As a result, fossil fuel usage grew marginally.

Meanwhile, investment in the global energy transition exceeded USD $2 trillion for the first time in 2024, according to Bloomberg NEF.[2] Electrified transport (USD $757 billion), renewable energy (USD $728 billion) and power grids (USD $390 billion) accounted for 90 per cent of that total, with all three growing to record levels.

666 GW

Approximate renewable capacity added worldwide in 2023

(2023: approx. 2510 GW)

$728 bn (USD)

Global investment in renewable energy 2024

(+17% year-on-year)

$757 bn (USD)

Global investment in electrified transport 20234

(+19% year-on-year)

The Asia Pacific region grew fastest, at 21 per cent year on year, with China alone accounting for two-thirds of global growth, investing a staggering USD $818 billion in 2024 – more than double that of any other economy.

[1] International Energy Agency, *Renewables 2024*
[2] BloombergNEF, *Energy Transition Investment Trends 2025*

Despite over USD $2 trillion in global investment, reaching net zero by 2050 would, according to BloombergNEF, require an average of USD $5.6 trillion between 2025 and 2030.

International policy

Last year we highlighted the transformative effect of the United States' Inflation Reduction Act (IRA), which brought a significant wave of investment into the US' renewable energy project pipeline over the course of 2023.

With the Trump Administration elected in the US in January 2025, it is unclear to what extent the positive momentum brought about by the IRA will be sustained or stalled. A raft of early executive orders rolled back many of the previous administration's efforts in the renewable energy space, including freezes on funding for clean energy projects and withdrawal from the Paris Climate Agreement.[3]

The effect this will have on the US energy market remains to be seen. Some have speculated that with electricity demand growing thanks in part to new developments such as AI tools, the US' energy system could be in danger as a result of these changes.[4]

In its 2025 Renewable Energy Industry Outlook, however, Deloitte suggested that despite the change in administration, "historical data suggests market-driven growth fundamentals will continue to shape renewable deployment regardless of policy priority changes."[5]

What effect Trump's actions have on the global marketplace – many of whose jurisdictions had moved towards similar policies to the IRA – is an even bigger consideration. There is a possibility that the investment, talent and resources that were being drawn to the US' IRA-framed agenda may look to move elsewhere, giving other jurisdictions a bigger slice of the pie.

Europe continues to implement comprehensive climate and clean energy policies, meanwhile, with significant policy movements such as the Carbon Border Adjustment Mechanism, which is in the final year of its transitional phase before becoming definitively active in 2026 . The mechanism applies a price on the "carbon emitted during the production of carbon intensive goods that are entering the EU"[6] and is part of a wider global tend towards this kind of action. According to the World Bank, some 40 countries and more than 20 cities, states and provinces already use carbon pricing mechanisms, with more planning to implement them in future.

These moves suggest that, going forward, jurisdictions should pay close attention to the value of decarbonisation, as highly carbon-intensive exports may incur costs in an increasing number of countries.

COP 29, held in November in Azerbaijan, produced few concrete results, with little progress on mitigation, and an agreement on raising the level of climate finance for vulnerable and developing countries that was widely regarded as insignificant for the fight against the climate crisis and for climate justice. A deal to provide around USD $300 billion a year by 2035 in climate finance for developing countries was not considered sufficient in many corners, despite being more than double the previous contribution commitment.[7] However, the gathering did build on the existing goal of tripling global renewable energy capacity by 2030, with new global commitments to increase energy storage by 1,500 GW and to develop 25 million kilometres of grid infrastructure by 2030.

> "With the Trump Administration now in government in the US, it is unclear to what extent the positive momentum brought about by the Inflation Reduction Act will be sustained or stalled

A pivotal year

According to the IEA's *World Energy Outlook 2024* report, "markets for traditional fuels and clean technologies are becoming more fragmented: since 2020, almost 200 trade measures affecting clean energy technologies – most of them restrictive – have been introduced around the world, compared with 40 in the preceding five-year period.

It is clear that 2024 is likely to be looked back on as pivotal year for global decarbonisation and for the renewable energy transition.

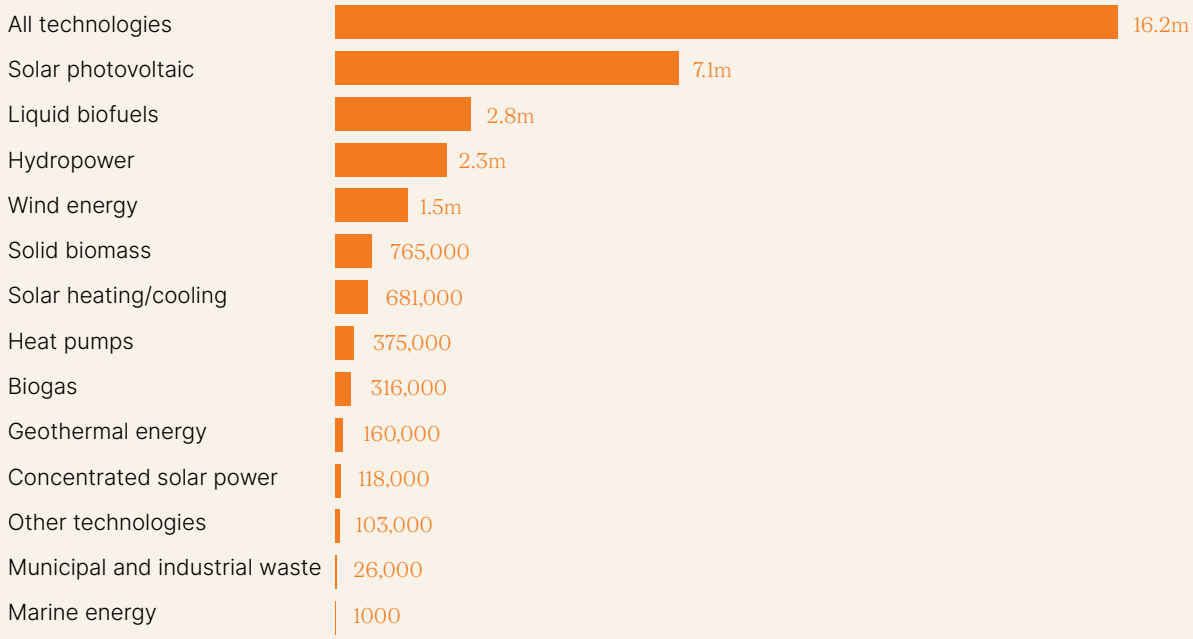
[3] T Stuart, *The Conversation,* https://theconversation.com/trumps-reversal-of-climate-policies-risks-undermining-u-s-manufacturing-and-could-cost-people-jobs-248399
[4] A Chu, J Smyth, The Financial Times, https://www.ft.com/content/47dbfee3-5517-43c6-85ab-dfe86d2d4085
[5] C Amon, K Hardin, T Keefe, M Motyka, Deloitte, *2025 Renewable Energy Industry Outlook*
[6] European Commission, https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en
[7] M McGrath, BBC, https://www.bbc.com/news/articles/cp35rrvv2dpo

With BloombergNEF forecasting that global energy transition investment will need to almost triple if the world is to reach net zero by 2050, there is a significant amount of work still to be done. US investment in the transition was approximately USD $338 billion in 2024, and the US has been a fairly stable contributor. That figure now clearly in danger of reducing, the world must come together to find ways of funding the transition.

Any reduction in US renewable energy activity should present huge growth opportunities for other jurisdictions, like Australia, to stake their claims to the renewable economy of the future.

Notwithstanding the increased uncertainty and choppy waters of geopolitics in 2025, with strong fundamentals supporting the march of clean energy technologies (including increasing global production capacity and subsequent falling prices) we expect that investment growth will continue, particularly in those areas that maintain the benefits of free and open trade.

Global renewable energy employment by technology, 2022 (millions)



*Other technologies includes jobs not broken down by individual energy technologies

Source: International Renewable Energy Agency, *Renewable Energy and Jobs Annual Review 2024*

Bundaberg Solar Farm
Bundaberg, QLD
Taribelang Country
(Monford Group)

Technology profiles

Waratah Super Battery
Colongra, NSW
Darkinjung Country
(Akaysha)

TECHNOLOGY PROFILE

Battery storage

Utility scale storage has once again delivered a huge year, with 38 projects under construction and massive levels of investment.

Large-scale battery storage projects boomed again in 2024. Following on from a massive 2023, it's reassuring to see that the storage sector – which will be so crucial to maintaining grid reliability as coal exits – continues to enjoy considerable backing.

There were 38 large-scale batteries under construction in Australia at the end of 2024, significantly up from 27 in 2023, which was already significantly up from 19 projects in 2022.

Those projects will provide 8.7 GW / 23.3 GWh of capacity, considerably up on the 5 GW / 12 GWh that was under construction at the end of 2023. Considering those figures were just 1.4 GW / 2 GWh in 2022, it really demonstrates how far the sector has come in a short time.

Thanks to the influx of new activity, the top-five largest utility scale battery systems under construction looks quite different this year to 2023.

At 850 MW / 1,680 MWh, the largest project in development remains the Waratah Super Battery in New South Wales. The project has completed construction and commissioning should be completed in the coming months.

The Waratah Battery will deliver some innovative new system services, having been contracted to deliver a 'system integrity protection scheme' that will increase power transfer from new renewable energy zones in northern and western NSW. [1]

[1] Australian Energy Regulator, https://www.aer.gov.au/industry/registers/determinations/waratah-super-battery-sips-battery-service

38

large-scale batteries under construction at end of 2024

(2023: 27)

8.7 GW/ 23.3 GWh

approximate capacity of large-scale batteries under construction at end of 2024

(2023: 5 GW /12 GWh)

$3.7 billion

New financial commitments in large-scale storage

(2023: $6.9 billion)

Until projects are fully commissioned, they are reported as 'under construction', so the capacity contributions of the Waratah Super Battery are included in the total figures above.

The next-largest battery under construction is the 600 MW / 1.6 GWh Melbourne Renewable Energy Hub Battery Energy Storage System (Phase 1). Commercial operation is scheduled to begin sometime in 2025.

The top five also includes the ongoing projects to build large-scale batteries at the Eraring and Liddell power stations. The former's coal-fuelled operations were extended in 2024 and continues to operate, but Liddell has been closed since mid-2023. These two assets reflect a continuing trend of utilising the sites of retired or soon-to-retire fossil fuel generators for new battery energy storage systems (BESS), taking advantage of existing connection assets and associated infrastructure. Other examples of brownfield BESS development on old fossil generator sites include the Hazlewood BESS in Victoria, the Torrens Island BESS in South Australia and potential new BESS at the Wallerawang site in NSW.

Sitting just outside the top five is stage two of Neoen's Collie Battery, at 341 MW / 1.4 GWh. The first stage of the facility is already operating, having completed construction ahead of schedule, and is providing 219 MW / 877 MWh in southwest Western Australia. In April 2024, Neoen was awarded a contract to nearly triple the size of the existing project.[2] When complete, the additional stage will make the Collie Battery the largest in Australia.

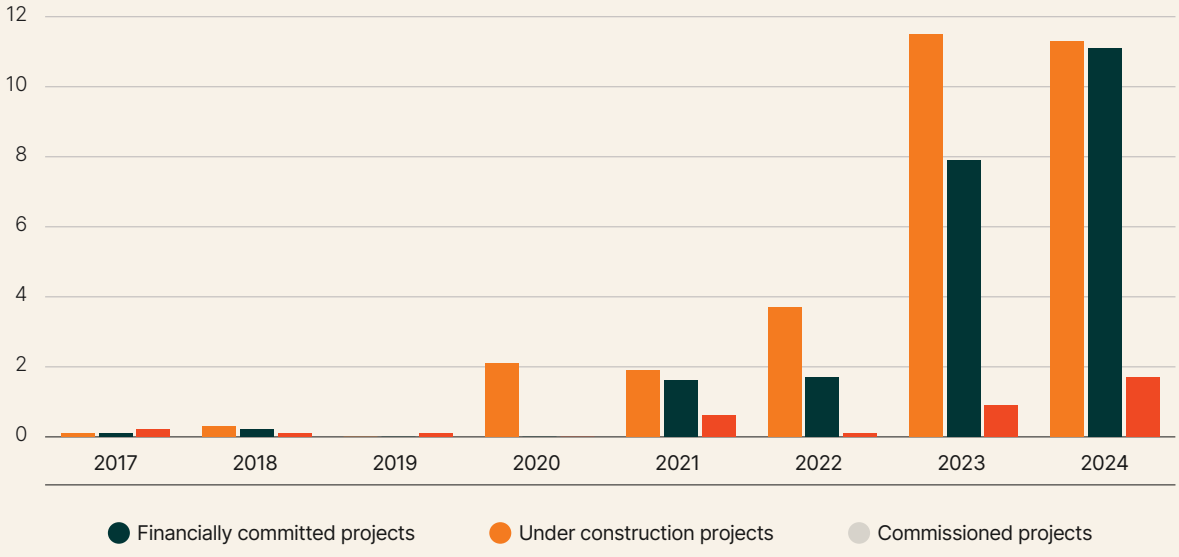
The Collie battery is particularly interesting as it pilots a new type of non-cooptimised essential system service contract, whereby the battery is contracted to provide a 4-hour response during the evening peak.[3] This contract type demonstrates the key role batteries can play in managing reliability as the power system shifts to higher levels of renewable energy.

Three of the five largest batteries under construction are located in New South Wales (including the Eraring and Liddell batteries), one in Victoria and one in Western Australia. The 38 batteries under construction are spread fairly evenly around Australia.

Eight projects with storage components were selected as part of the first round of the Capacity Investment Scheme in late 2024, as the Federal Government's investment mechanism kicks off. The largest of the projects was Windlab's Junction River in NSW, which will provide 585 MW / 800 MWh and is a wind/storage hybrid.

As of the end of 2024, there is over 8.7 GW / 23.3 GWh of large-scale battery capacity under construction in Australia. That is not only more big battery storage than is currently operational in Australia – it's more than a third of Australia's coal-fired power stations combined.

Total energy output of large-scale battery storage projects by development stage (GW)



[2] G Parkinson, RenewEconomy, https://reneweconomy.com.au/neoens-collie-battery-to-be-australias-biggest-after-winning-new-contract-to-flatten-solar-duck/
[3] Neoen, https://neoen.com/en/news/2024/neoen-to-build-stage-2-of-collie-battery-after-winning-its-second-4-hour-storage-contract-in-australia/

Pipeline bears fruit

Five utility scale storage projects were connected to the grid in 2024, for a combined capacity of 619 MW / 1,677 MWh.

The final quarter of 2024 was a record-breaking one, as more than 1 GWh worth of battery projects came online in a single quarter for the first time. Those projects were the Rangebank BESS in Victoria (100 MW / 200 MWh) and the Collie Battery – Stage 1 in Western Australia (219 MW / 877 MWh). The Collie Battery – Stage 1 was also the largest battery in terms of capacity commissioned in Australia in 2024 This progress is a direct result of the strong volume of battery projects reaching financial commitment in the past two years, and which should continue given 2024's strong investment numbers – read more below.

Five biggest large-scale battery systems under construction at end of 2024

State	Project Name	Project owner	Locality	Size of system (MW / MWh)
NSW	Waratah Super	Akaysha Energy	Colongra	850 / 1,680
VIC	Melbourne Renewable Energy Hub – Phase 1	Equis Australia	Melton	600 / 1,600
NSW	Liddell Power Station	AGL Energy	Muswellbrook	500 / 1,000
WA	Collie BESS (by Synergy)	Synergy	Collie	500 / 2,000
NSW	Eraring Battery – Stage 1	Origin Energy	Eraring	460 / 920

Storage expansion

After a record-breaking year for new financial commitments to utility scale storage in 2023, 2024 had a tough act to follow. Publicly announced information puts the total for new financial commitments in 2024 at $3.7 billion from 17 projects, which is a strong number but down on the record of $6.9 billion in 2023. Those projects will provide 4 GW / 11.3 GWh of new capacity, which is more capacity than is currently operational in Australia.

The largest of those newly committed projects is Akaysha Energy's Orana Battery Energy Storage System, at 415 MW / 1.6 GWh, in New South Wales. The project, which secured $650 million in funding in 2024, is scheduled to come online in 2026. At the time of announcement, Akaysha announced this to be the largest investment in a single battery anywhere in the world.[4]

Of all the storage projects committed in 2024, five are located in Queensland, four in New South Wales, three in South Australia, three in Victoria and one in Western Australia. Of the 24 projects that reached financial commitment, 14 are accompanying a generation project, the largest of which is Lightsource BP's Woolooga BESS in QLD, at 222 MW / 640 MWh.

The actual investment figure for 2024 is almost certainly much higher than $3.7 billion, as not all projects (at time of writing) have provided publicly available investment figures.

At the time of writing, several projects' investment values have not been disclosed, for example Neoen's Western Downs BESS Stage 2, at 270 MW / 540 MWh, and the previously mentioned Woolooga battery, at 222 MW / 640 MWh.

In its latest *Integrated System Plan*, the Australian Energy Market Operator forecasts Australia will need at least 49 GW of storage by 2050. Large-scale storage figures from recent years show significant signs of progress towards that goal.

A key trend is the continuing growth in both power rating and duration of large BESS. Clean Energy Council analysis shows the average duration of the BESS is growing – projects commissioned in 2024 averaged 2.7 hours. This reflects a growing trend toward 4-hour duration batteries in the National Electricity Market (NEM), which the market has identified as being necessary to cover evening peak periods.

While there are some examples of longer duration 8-hour BESS in the NEM, such as the Limondale BESS in NSW, it appears that 4 hours is currently the trending duration. Further work is needed to explore new market mechanisms to incentivise the longer durations that will become increasingly important as the NEM evolves.

[4] R Williamson, RenewEconomy, https://reneweconomy.com.au/huge-finance-deal-and-off-take-landed-for-one-of-australias-biggest-four-hour-battery-projects/

RayGen Power Plant Carwarp
Carwarp, VIC
Latji Latji Country
(RayGen)

CASE STUDY

Innovation in long-duration energy storage and solar generation with RayGen

Energy storage is an essential element of the clean energy transition, moving energy through time to when it's most needed. There are many forms of energy storage, including widely used lithium batteries and pumped hydro facilities.

Alternative long-duration energy storage technologies, such as compressed air, thermal energy and redox flow batteries, are becoming increasingly mature and will soon be in a position to complement existing energy storage technologies at scale.

RayGen's solar/thermal hydro Carwarp project is a first-of-its-type technology demonstration plant in northwest Victoria, providing 4 MW of solar generation capacity and 2.8 MW / 50 MWh of storage. RayGen's solar hydro solution combines concentrated solar electricity and heat generation with a water-based thermal storage solution that can provide dispatchable, synchronous energy over periods exceeding 12 hours. At Carwarp, four solar towers each generate 1 MW of electricity and 2 MW of heat, while two water pits store thermal energy. It began exporting solar energy to the grid in 2022 and was commissioned in July 2023.

At the opening of Carwarp, Darren Miller, CEO of the Australian Renewable Energy Agency, said: "We know that we need firm dispatchable energy. We know that the grid needs it as we decarbonise and this technology is a really crucial element in the electricity system to have both cheap generation as well as the storage that we need."

RayGen's Solar-Hydro technology is next planned to be deployed on a commercial scale in Yadnarie, South Australia, in a project that will comprise 150 MW of solar generation, 90 MW of thermal hydro storage and at least 720 MWh of energy storage. The project is forecast to create 250 jobs during construction and 20 ongoing regional jobs.

Household battery boost

The latest figures from SunWiz for household battery installations are also very positive, with 185,798 units now installed across Australia. The second half of 2024 saw 45,233 units sold – 55 per cent more than the same quarter in 2023. In total, 74,582 home batteries were sold in Australia, up from approximately 46,000 in 2023.

Around 4.6 per cent of the 4 million solar installations have a battery connected, and in 2024, around 23 per cent of installations came with an attached battery, up from around 7 per cent in 2023. This shows the growing trust in the value of household batteries, which complement rooftop solar to bring down energy bills and offer greater energy independence. State government-schemes to support household batteries vary across Australia. New South Wales introduced its battery subsidy program in November 2024, while Queensland's Battery Booster program ended in May. There are rebate and loans available in NSW, Victoria and the Northern Territory. The Clean Energy Finance Corporation offers the Household Energy Upgrades Fund, but there is room for a Federal Government scheme to more broadly support battery uptake.

For more information on the rooftop solar sector, see our rundown on pages 69.

Brendale BESS
Brendale, QLD
Turrbal Country
(Akaysha)

TECHNOLOGY PROFILE

Bioenergy

The policy environment continues to be supportive as bioenergy opens doors to low-carbon fuels.

For Australia's low-carbon fuel and renewable gas industries, 2024 was a year of momentum. From significant government funding to collaboration between industry stakeholders, we saw growth in project and policy development, engagement from decision-makers, and growing recognition of the role these low-carbon fuels could play in Australia's energy transition.

Policy momentum gathered pace in 2024 for low-carbon liquid fuels, in which bioenergy is expected to play an important role, particularly in the medium term. Australia is set to become a significant player in the development and deployment of low-carbon liquid fuels, including renewable diesel and sustainable aviation fuel (SAF), with these fuels forming a key component of the 2024-25 Federal Budget.

The industry received unprecedented support in the 2024-25 Federal Budget through the Future Made in Australia initiative, which included:

- Investing $1.7 billion over the next decade in the Future Made in Australia Innovation Fund, to support the Australian Renewable Energy Agency to commercialise net zero innovations including low-carbon fuels.
- $18.5 million over four years from 2024–25 to develop a certification scheme for low-carbon liquid fuels, including sustainable aviation fuels, in the transport sector by expanding the Guarantee of Origin scheme.
- $1.5 million over two years from 2024–25 to undertake a regulatory impact analysis of the costs and benefits of introducing mandates or other demand-side measures for low-carbon liquid fuels.
- The Federal Government undertaking targeted consultation to identify options for production incentives to support the establishment of a made-in-Australia low-carbon liquid fuel industry.

With these announcements, the Australian Government identified low-carbon liquid fuels and renewable gas as priority areas that will be crucial in the energy transition and has committed to supporting project developers with funding options.

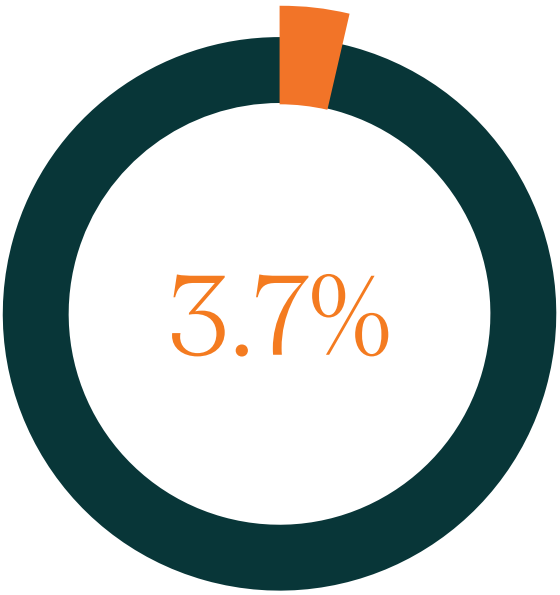
These announcements signal to global project developers and investors that Australia is ready and willing to accelerate the industry. Australia is already considered a potential global low-carbon fuels hotspot given its vast agricultural sector and industrial base , with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) reporting that Australia will have enough feedstock in 2025 to replace 60 per cent of local jet fuel with SAF, growing to 90 per cent by 2050.[1]

Additional supportive policy has been adopted at both Commonwealth and state levels. This includes:

- The inclusion of market-based reporting for renewable liquid fuels as part of the National Greenhouse and Energy Reporting scheme.
- The announcement that the Future Made in Australia (Guarantee of Origin) Bill 2024 will include low-carbon liquid fuels, biomethane, and biogas.
- The release of the Defence Future Energy Strategy and Net Zero Strategy, which highlight the role of low-carbon fuels in decarbonising the defence sector.

[1] Commonwealth Scientific and Industrial Research Organisation, https://www.csiro.au/en/work-with-us/services/consultancy-strategic-advice-services/csiro-futures/energy/sustainable-aviation-fuel-roadmap

Bioenergy generation in 2024



of total clean electricity generated in Australia in 2024

(2023: 3.5%)

of total electricity generation in Australia in 2024

(2023 1.4%)

- The release of the Future Gas Strategy, which recognises the key role biomethane will play in reducing emissions for Australian gas users.
- The release of the Aviation White Paper, which identified SAF's major contribution toward net-zero aviation by 2050.
- The release of the Consultation on Future Made in Australia: Unlocking Australia's Low Carbon Liquid Fuel Opportunity, marking a significant step forward in defining the policy support needed to unlock this sector's potential.
- Work being undertaken to revise AS 4564: Specification for General Purpose Natural Gas to better support biomethane injection.
- The formalisation of the GreenPower Renewable Gas Guarantee of Origin into an established certification scheme.
- The release of the CSIRO and Boeing SAF State of Play Report Update, which provides an updated overview of domestic and international SAF developments, along with key recommendations to accelerate industry growth.
- The release of the Opportunities for a Renewable Fuel Industry in New South Wales discussion paper, marking a significant step forward for renewable fuels in NSW.
- The release of the NSW Government's Sustainable Aviation Fuel Prospectus.
- Critical funding announced as part of the Queensland Government's Industry Partnership Program (IPP) to support Queensland's SAF industry, with total IPP funding now reaching $415.5 million.
- The release of Victoria's Industrial Renewable Gas Guarantee Directions Paper, which recognises the critical role of renewable gas and proposes the country's first Renewable Gas Target.

While further work is needed to ensure these new and developing schemes effectively support the industry, these announcements reflect increasing recognition and support for the sector as research clearly identifies the potential benefits.

Article provided by Bioenergy Australia

Kidston Pumped Hydro Project
Kidston, QLD
Ewamian Country
(Genex Power)

TECHNOLOGY PROFILE

Hydro and pumped hydro

With two projects nearing completion, it is likely Australia will soon have its first new pumped hydro development in over 40 years, providing crucial additional capacity to back up renewable generation.

Hydropower provided 13,295 GWh of generation in 2024, down from 15,307 GWh in 2023. It contributed 5.5 per cent of Australia's electricity generation in 2024, down from 6.5 per cent in 2023, and 13.7 per cent of Australia's renewable generation, also down on 2023 (16.4 per cent).

The lower output from hydro power was the result of a range of factors including lower rainfall and water inflows in some regions of the country as well market dynamics and pricing factors in some regions.

There are three pumped hydro projects currently under construction in Australia, and the first to begin operations will become the first new pumped hydro development in Australia in over 40 years.

Genex Power's 250 MW / 2,000 MWh Kidston Pumped Storage Hydro Project in Queensland continues through its construction phase, with Genex suggesting the project is likely to be energised in the second half of 2025. The Altura Group's 230 MW / 1,840 MWh Goat Hill Pumped Storage Hydro Project in South Australia, at the time of writing, is also still under construction.

The largest project under construction is Snowy Hydro's Snowy 2.0 project in New South Wales, which when complete will bring capacity of 2 GW / 350 GWh. In late 2024 a planning modification was lodged to bring in a fourth tunnel boring machine to help keep the project on schedule. Subject to approval, the new machine will be tunnelling before the end of 2025. According to Snowy Hydro, the project will "generate enough flexible, fast-dispatch energy to power 3 million homes continuously for a week".[1]

Unfortunately, the proposed Pioneer-Burdekin Pumped Hydro Project, which would have provided 5 GW / 120 GWh of capacity, has been cancelled by the Queensland Government.[2] The Government cited financial unviability and lack of community consultation among the reasons for the cancellation. The project was a significant part of QLD's energy transition plans under the former administration and it remains to be seen what projects will replace it.

13,295 GWh

hydropower generation

(2023: 15,307 GWh)

-13.1%

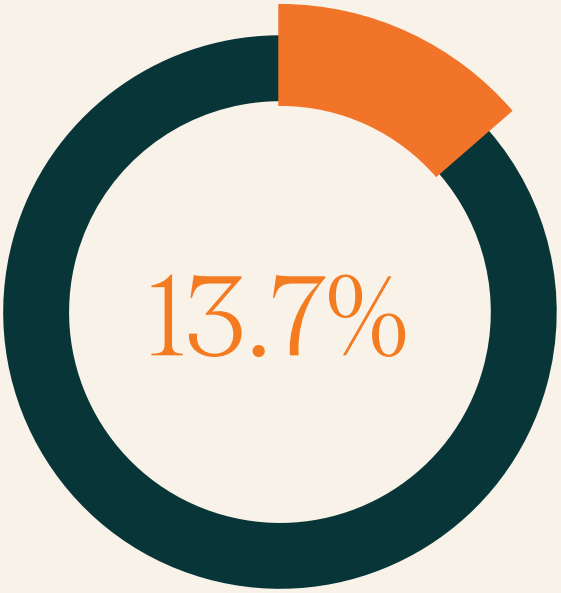
annual decrease in hydropower generation

(2023: -7.7%)

[1] Snowy Hydro, https://www.snowyhydro.com.au/news/snowy-2-0-confirms-fourth-tunnel-boring-machine-to-protect-delivery-timeline/

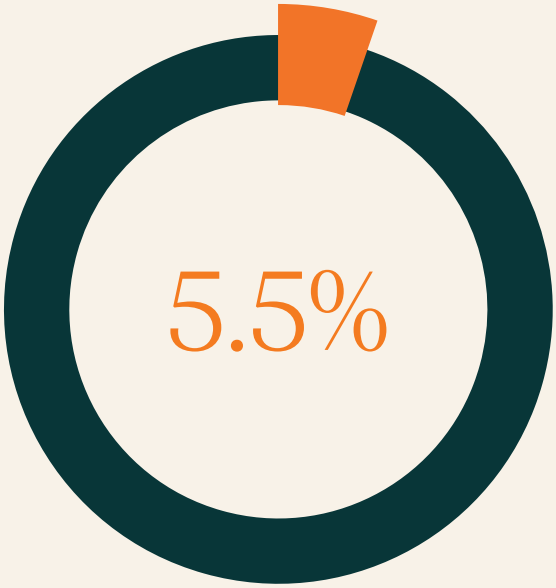
[2] A Messenger, The Guardian, https://www.theguardian.com/australia-news/2024/nov/04/new-queensland-government-bins-labors-hydro-project-set-to-be-key-part-of-renewable-transition

Hydropower generation in 2024



of total clean electricity generated in Australia in 2024

(2023: 16.4%)



of total electricity generation in Australia in 2024

(2023: 6.5%)

Hydropower contribution to Australian electricity generation

Year	Generation (GWh)	Contribution to renewables	Contribution to total electricity
2013	19,243	55.4%	8.2%
2014	14,555	45.9%	6.2%
2015	14,046	40.1%	5.9%
2016	17,747	42.3%	7.3%
2017	13,331	34.6%	5.9%
2018	17,002	35.2%	7.5%
2019	14,166	25.7%	6.2%
2020	14,638	23.3%	6.4%
2021	16,128	21.6%	7.0%
2022	16,537	19.7%	7.1%
2023	15,307	16.1%	6.4%
2024	13,295	13.7%	5.5%

The proposed Borumba Pumped Hydro Project at Lake Borumba in Queensland continued to progress in 2024, with the project currently undergoing early works and investigations while Queensland Hydro seeks regulatory approvals for exploratory works.[3]

Meanwhile, significant progress is being made in early stage development of a range of hydropower projects across Australia, and a range of investments by Hydro Tasmania to expand and/or modernise the significant existing hydropower assets across Tasmania.

[3] Queensland Hydro, https://qldhydro.com.au/wp-content/uploads/2025/02/Borumba_Works-update_Feb-2025_FINAL.pdf

Kidston Pumped Hydro Project
Kidston, QLD
Ewamian Country
(Genex Power)

TECHNOLOGY PROFILE

Hydrogen

Australia's economy could benefit significantly from continued investment in and support for hydrogen production.

From the decarbonisation of heavy industry to grid firming and export to international markets, hydrogen represents a strong opportunity for Australia. It is an opportunity recognised by the Federal Government, which has put in place multiple avenues of support for the sector, particularly over the past year.

The 2024-25 Federal Budget was an historic one for clean energy in Australia, with billions of dollars of support announced, including some significant wins for the hydrogen sector.

Those included $6.7 billion over a decade for a Hydrogen Production Tax Credit, which has since been passed into law as part of the *Future Made in Australia Bill*, and $2 billion for a second round of the existing Hydrogen Headstart program, announced in 2023, which is administered by the Australian Renewable Energy Agency (ARENA).

Later in 2024, the Federal Government released its National Hydrogen Strategy 2.0, increasing the focus on the most prospective use cases for renewable hydrogen, which include green iron, chemical feedstocks and clean fuels including green ammonia, methanol and sustainable aviation fuels, all of which will be critical solutions for decarbonisation of hard-to-abate and hard-to-electrify industries.

In addition, the passing of the Guarantee of Origin Act in December 2024, which will implement an emissions accounting framework for Australia, supporting the development of green industries. The Guarantee of Origin scheme will commence with renewable electricity and hydrogen, expanding in future to products such as low-carbon liquid fuels and green metals.

Supply and demand

Hydrogen projects have been progressing more slowly than anticipated for a range of reasons, including project and operational costs increasing due to the COVID pandemic and the global energy crisis. As those factors being to ease, development has remained challenging due to the lack of demand-side policy.

Hydrogen Headstart and the Hydrogen Production Tax Credit are designed to support lower-cost production, but mechanisms to catalyse demand for green hydrogen and its derivatives are a missing piece of the puzzle. In Australia, as is the case globally, demand for green hydrogen has not yet hit expected heights, with large-scale green hydrogen projects reporting in a 2024 Clean Energy Council survey that a lack of demand-side policy remains the largest barrier to investment.

The International Energy Agency's (IEA) *Renewables 2024* report also indicates that renewable hydrogen projects are not fulfilling prior expectations, "mainly due to insufficient demand creation".

The Australian Government's National Hydrogen Strategy highlights the necessity for driving demand and flags several potential factors. According to the strategy, "global demand for green iron and steel is forecast to grow significantly by 2050". The IEA highlights that Australia has a hydrogen project pipeline that "adds up to nearly 10 times the current domestic hydrogen demand".[1]

One development to come out of the release of the Strategy was the signing of a $660 million deal between Germany and Australia for a dedicated auction for Australian green hydrogen producers, with guaranteed offtake for successful bidders from European markets, which may begin to spark the demand required.

[1] International Energy Agency, *Global Hydrogen Review 2024*

Opportunities to be grabbed

There is a broad consensus that there are significant economic opportunities for Australia in the production of green hydrogen. The Hydrogen Council released its *Hydrogen Insights 2024* report in September 2024, which estimated that 1,572 hydrogen projects have been announced globally, amounting to USD 680 billion in announced investments through 2030.[2]

In late 2024, a report from the Commonwealth Scientific and Industry Research Organisation (CSIRO) predicted that Australia's hydrogen electrolyser manufacturing sector could generate $1.7 billion in revenue and create nearly 4,000 jobs by 2050.[3]

CSIRO's Futures Energy Lead, Vivek Srinivasan, echoed the sentiments of the Australian Government and others by highlighting how important it is for Australia to grab the opportunity to make a statement in a nascent industry: "By leveraging [its] renewable energy advantages and innovative R&D capabilities, Australia can become a player in this rapidly emerging sector – but we must act quickly while the opportunity is available to us."

> "Not only is green hydrogen production a massive economic opportunity, it also represents a necessary next step for Australia's huge iron ore export industry

On release of its National Hydrogen Strategy, the Federal Government quoted the IEA's forecast that 20 per cent of all announced hydrogen projects globally are in Australia.

State governments across Australia are also recognising the potential in renewable hydrogen. In last year's *Clean Energy Australia* report some of these were noted, including New South Wales awarding $109.3 million of funding from its hydrogen initiative to three projects, and Queensland announcing investment in $69.2 million to develop the Central Queensland Hydrogen Hub.

In October 2024, the Western Australian Government released an updated Renewable Hydrogen Strategy 2024-2030, aimed at supporting the development of the renewable hydrogen industry in WA. According to the WA Government, the strategy "could add billions to the WA economy, provide thousands of extra jobs each year, and ensure WA continues to contribute to local and global industry decarbonisation".[4] The strategy states that it is aiming to have a renewable hydrogen project approved, in collaboration with Aboriginal peoples, by 2028.

International competition

Not only is green hydrogen production a massive economic opportunity, it also represents a necessary next step for Australia's huge iron ore export industry, which is already seeing a decline,[5] according to the Institute for Energy Economics and Financial Analysis (IEEFA).

IEEFA points out that the hydrogen industry, while in its early stages, is already in development around the world: "Truly green steel made with green hydrogen is on its way at commercial scale. Stegra's under-construction green steel plant in Sweden will begin commercial operations [in 2025]."

The continued rise of international competition is a trend Australia will need to reckon with. In its Global Hydrogen Review,[6] the IEA reports that China accounted for more than 40 per cent of global financial investment decisions (FID) on hydrogen projects over the past year, while European FIDs for electrolysis projects quadrupled over the same period.

According to Research and Markets, the Australian hydrogen market was valued at USD 4.25 billion in 2023 and is expected to reach USD 5.4 billion by 2029.[7]

Australia is ideally placed to be a producer of commodities such as green metals and clean fuels, which green hydrogen production will support, in addition to a wealth of other uses.

Subject to continuing, focused support from Australian Governments on prospective use cases, in addition to new internation opportunities on the horizon, we should see continued development of the hydrogen sector in Australia, even if at a more gradual rate over the long term.

[2] Hydrogen Council, *Hydrogen Insights 2024*
[3] CSIRO, *Hydrogen Electrolyser Manufacturing*
[4] Western Australian Government, https://www.wa.gov.au/government/announcements/updated-renewable-hydrogen-strategy-wa
[5] S Nicholas, Institute for Energy Economics and Financial Analysis, https://ieefa.org/resources/2025-australia-needs-accept-its-iron-ore-and-coal-markets-are-changing-permanently-and
[6] International Energy Agency, *Global Hydrogen Review 2024*
[7] Research and Markets, https://www.researchandmarkets.com/reports/6035109/australia-hydrogen-market-region-competition

Milestones Early Learning
South Grafton, NSW
Gumbaynngirr Country
(Coffs Solar)

TECHNOLOGY PROFILE

Rooftop solar
(Systems up to 100 KW)

With installations passing four million nationwide and capacity added close to record levels, 2024 was another stellar year for rooftop solar.

In a year in which utility scale generation was significantly down on 2023, rooftop solar continues to lead Australia's clean energy transition.

By surpassing four million installations, Australia solidified its position as a world leader in rooftop solar and reaffirmed that solar is an attractive proposition to consumers and small businesses looking for greater energy independence and lower bills.

In 2024, 322,016 solar PV systems were installed across Australia, slightly down on 333,717 systems in 2023. But the headline figure is that those systems provided a total installed capacity of 3.2 GW (up from 3.1 GW in 2023), coming very close to the record set in 2021.

The fact that installed systems in 2024 contributed more capacity than in 2023, despite being slightly fewer, is because the average size of solar installations has continued to trend upwards (see graphic on page 75). This was the fifth year in a row that installation figures surpassed 300,000 units.

Rooftop solar accounted for 31 per cent of renewable generation in 2024 and 12.4 per cent of energy generation overall, numbers which are both up compared to 2023: 28.5 per cent and 11.2 per cent respectively.

The 3.2 GW of combined rooftop solar installed capacity in 2024 was considerably higher than the capacity added by large-scale renewable projects, which totalled approximately 2 GW (836 MW from wind and 1.2 GW from large-scale solar). The last time rooftop solar and utility scale generation provided roughly equal capacity was back in 2019.

332,016

rooftop solar installations in 2024

(2023: 333,717)

3.2 GW

rooftop solar capacity added in 2024

(2023: 3.1 GW)

4 million

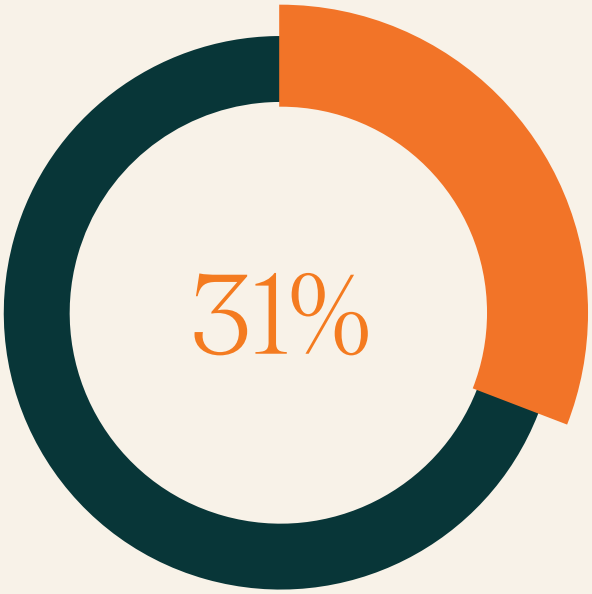
More than 4 million Australian households and small businesses with rooftop solar

(2023: 3.7 million)

Since then, the rooftop solar sector has led the transition.

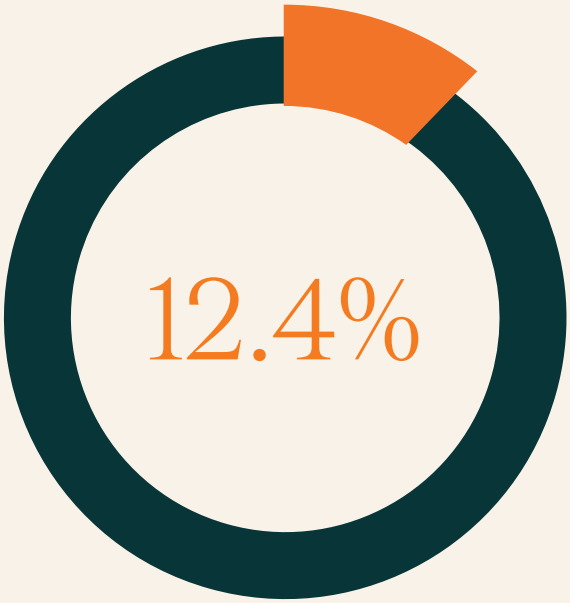
Rooftop solar now equates to over 25 GW of installed capacity in Australia, surpassing that of black and brown coal combined – another signifier of the progress Australia is making in its energy transition.

Rooftop solar generation in 2024



of clean energy generated in Australia in 2024

(2023: 28.5.%)



of total Australian electricity generated in 2024

(2023: 11.2%)

According to the Australian Energy Market Operator (AEMO), rooftop solar output reached an all-time quarterly high in all National Electricity Market (NEM) regions in Q4 2024, "with a NEM-wide average output of 4,054 MW, 18 per cent higher than the previous record of 3,433 MW set in Q4 2023".[1]

This was part of a wider trend which saw renewable energy sources account for a record 46 per cent of the total energy mix in the NEM in Q4 2024.

AEMO's Executive General Manager for Reform Delivery, Violette Mouchaileh, said: "The rise in rooftop solar output, coupled with record low coal-generation availability, resulted in coal-fired generation contributing less than 50 per cent of the NEM's total generation for the first time."

State of the sector

In 2024, New South Wales became the second state to pass one million rooftop solar installations, following Queensland in 2023. It added the highest amount of rooftop solar installations, at 98,531, with QLD in second place at 82,301. QLD still leads the country for overall installations, at 1.09 million, but NSW has added the most installations each year since 2018 and is not far behind at 1.06 million.

NSW installed over a gigawatt of rooftop solar capacity for the second year running, coming in just shy of the total it set in 2023, which remains a single-year record. The only other states to install less capacity in 2024 than in 2023 were the ACT (50.1 MW versus 85 MW) and South Australia (261 MW versus 263 MW) though these drop-offs were minor.

> "Rooftop solar now equates to over 25 GW of installed capacity in Australia, surpassing that of black and brown coal combined

[1] Australian Energy Market Operator, *Quarterly Energy Dynamics Q4 2024*

For the fifteenth straight year, the average size of solar systems installed trended upwards, reaching 9.98 kW compared to 9.41 kW in 2023. Even though technological advancements have improved the efficiency and output of solar panels, the average size of systems may continue to rise if there is a move towards broader optimisation focusing on additional opportunities like virtual power plant services and increased use of battery storage.

Backstops, flexible exports and electrification

As more and more solar generation enters the system across Australia, the need for emergency backstop mechanisms has grown. These ensure that for short periods, networks are able to remotely disconnect or prevent export from solar systems to maintain energy security and prevent load emergencies.

Emergency backstop mechanisms have now been introduced in South Australia, Western Australia, Queensland and most recently Victoria in October 2024. These provide an important means for ensuring the electricity grid remains stable under minimum demand conditions. As of early 2025, NSW has initiated consultation to introduce an emergency backstop mechanism for Spring 2025.

For more on emergency backstop mechanisms across Australia and planned updates in the years to come, turn to the energy reliability section on page 46.

Services that are in the process of being deployed, such as flexible exports, present another solution to better manage minimum demand issues and support effective rooftop solar integration into the grid, without inflexible curtailment.

As of early 2025, small-scale trials have been finalised across four distribution networks, with AusNet Services, Energex, Ergon Energy and SA Power Networks all offering flexible export limits to some customers across their networks. South Australia is the only state with full implementation in place. Additional NSW and Victorian distribution networks, including Jemena, Ausgrid and Endeavour, are proposing to develop flexible export services from 2025/26 onwards.

In October 2024, the Federal Government provided funding for the Electrify 2515 pilot in Wollongong, an initiative to help homes reduce energy bills through electrification and other energy smart improvements. That project is providing energy efficient appliances and consumer energy resources in participating homes in several areas.

The Federal Minister for Climate Change and Energy has since asked the Australian Renewable Energy Agency to consider funding for more community electrification projects across the country, which would provide valuable insights into how households can transition away from gas to electrification as quickly and efficiently as possible.

The next generation

The success of rooftop solar in Australia has been backed by stable federal government support, primarily through the Small-scale Renewable Energy Scheme, which has helped reduce upfront costs as well as building strong product and installer compliance requirements.

Batteries are a key component of the puzzle – their ability to store excess solar generation during the day to be used during the evening peak will help Australia better utilise its existing distribution network. This will bring down costs not only for the owners of the solar and battery systems, but for all energy users. Work carried out last year by the Clean Energy Council estimated this system-wide net value could be up to $190 million.

Many state governments have supported home batteries with state-specific battery rebate schemes, including the ACT, Queensland, South Australia and Victoria. More recently, New South Wales has shown support through its Peak Reduction Scheme.

The landscape is ripe for a nationally coordinated battery rebate program to build on the success of existing schemes, as well as continued focus on encouraging more orchestration of rooftop solar and storage, driven by informed consumers who have trust in the installation process.

Appetite and appreciation for rooftop solar is clearly present in Australia, demonstrated by consistently high numbers of installations. With the right support, rooftop solar will be the centrepiece of a wider electrification puzzle.

For more information on the battery energy storage sector, including household batteries, turn to page 55.

Medium-scale solar

(Systems between 100 kW and 5 MW)

157 MW

New medium-scale solar capacity added in 2024

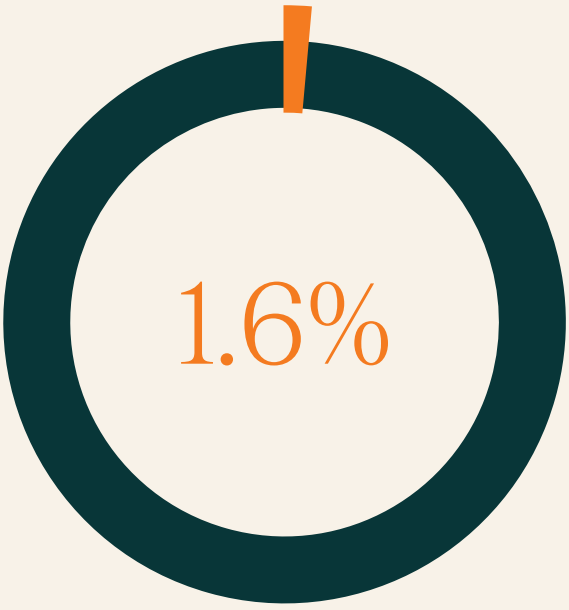
(2023: 170 MW)

1.1 GW

Total capacity of the medium-scale solar sector

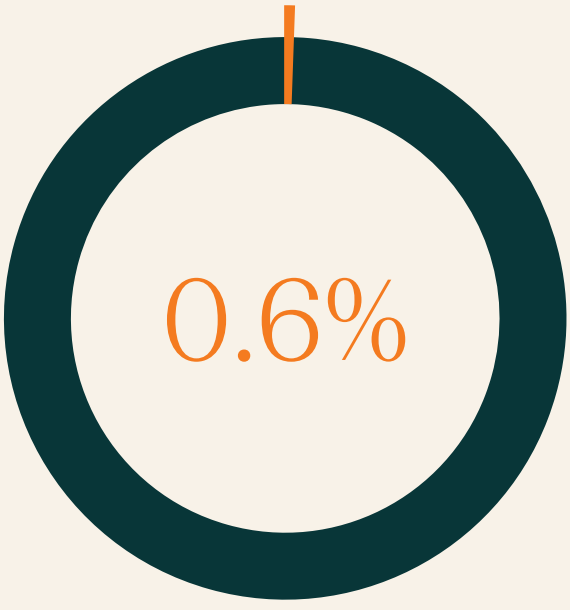
(2023: 933 MW)

Medium-scale solar generation in 2024



of renewable energy generation in Australia 2024

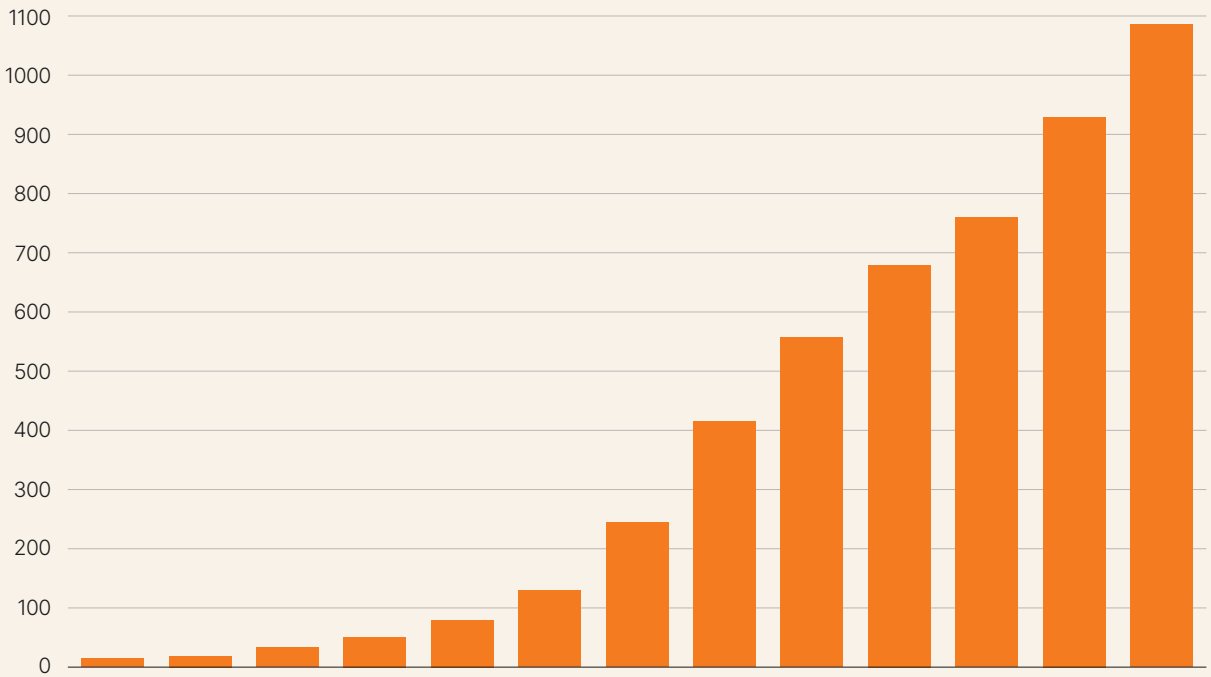
(2023: 3.9%)



of total energy generation in Australia 2024

(2023: 1.6%)

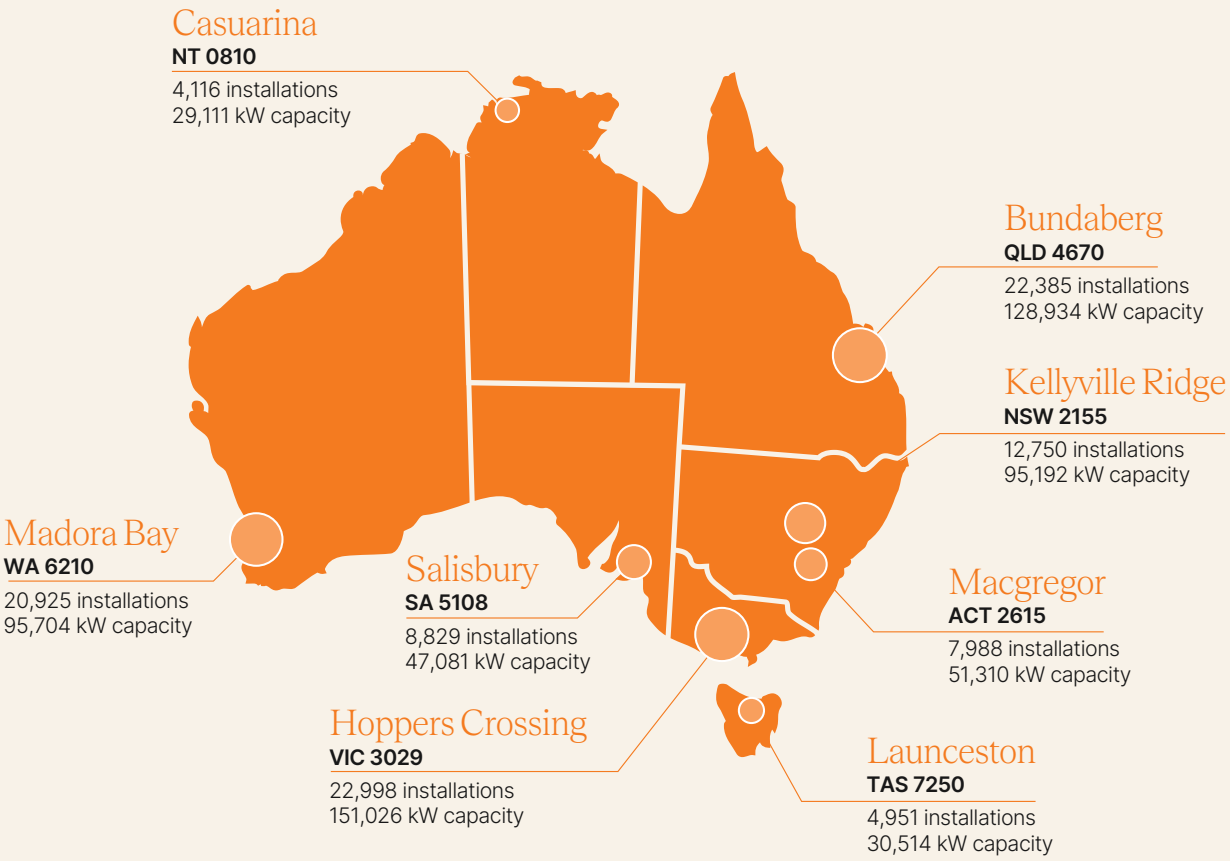
Cumulative installed capacity (MW) of medium-scale solar systems



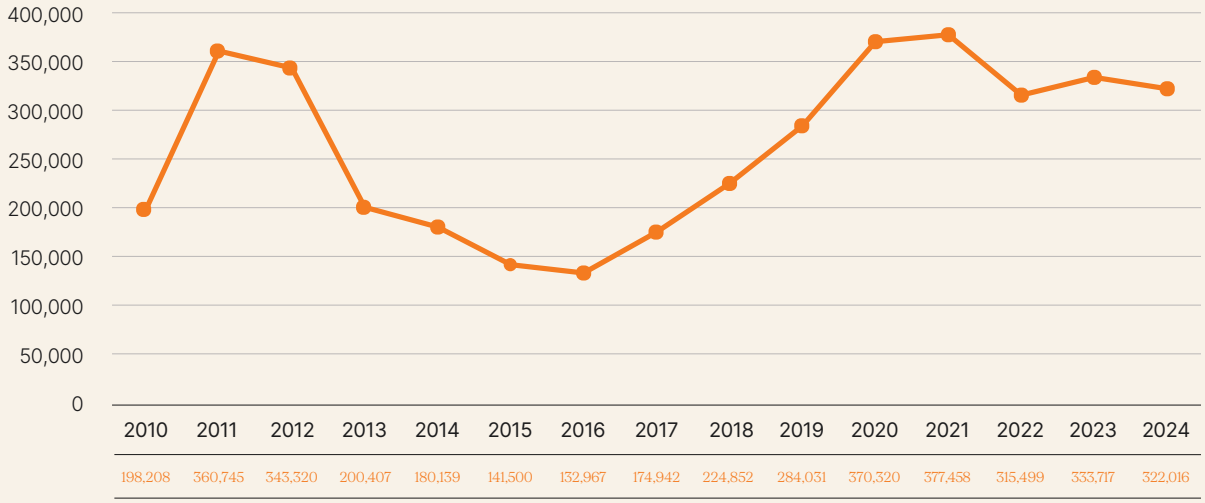
2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
15	19	33	51	80	130	245	416	559	682	763	933	1090

Note: Due to lags in Clean Energy Regulator processes for registration and publishing of data on the capacity of medium-scale solar systems, the figures listed for 2023 and 2024 are likely to be underestimated.

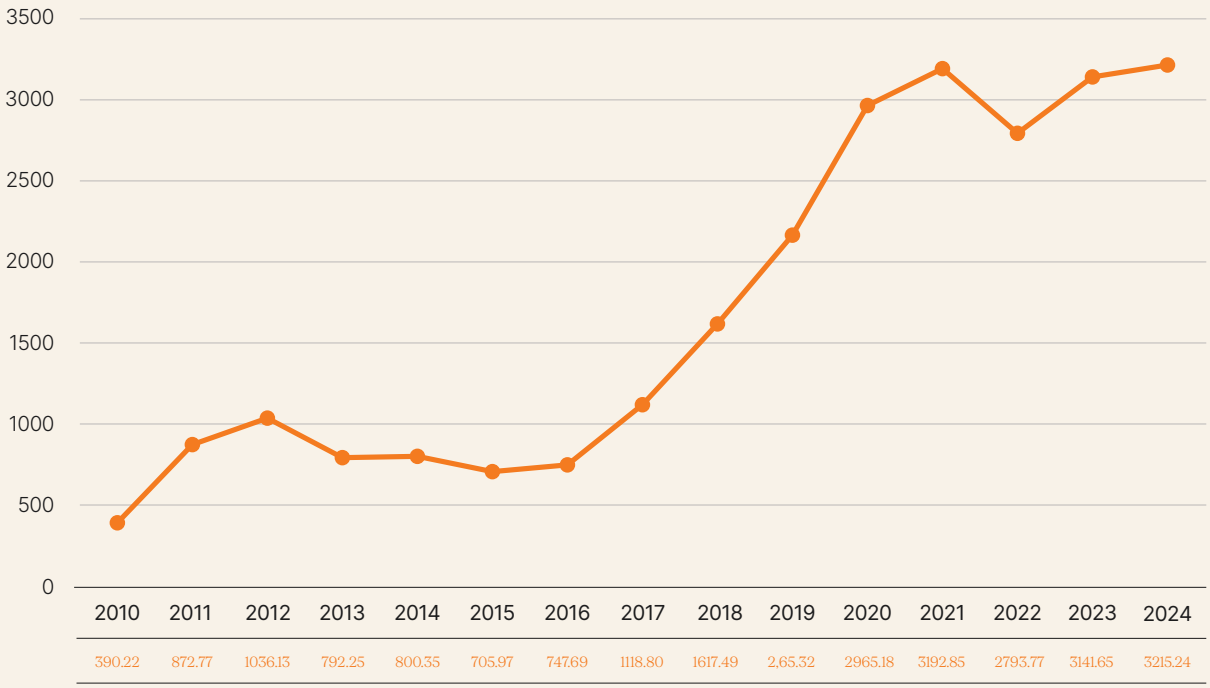
Top solar postcodes in each state, by number of installations



Annual solar PV installations

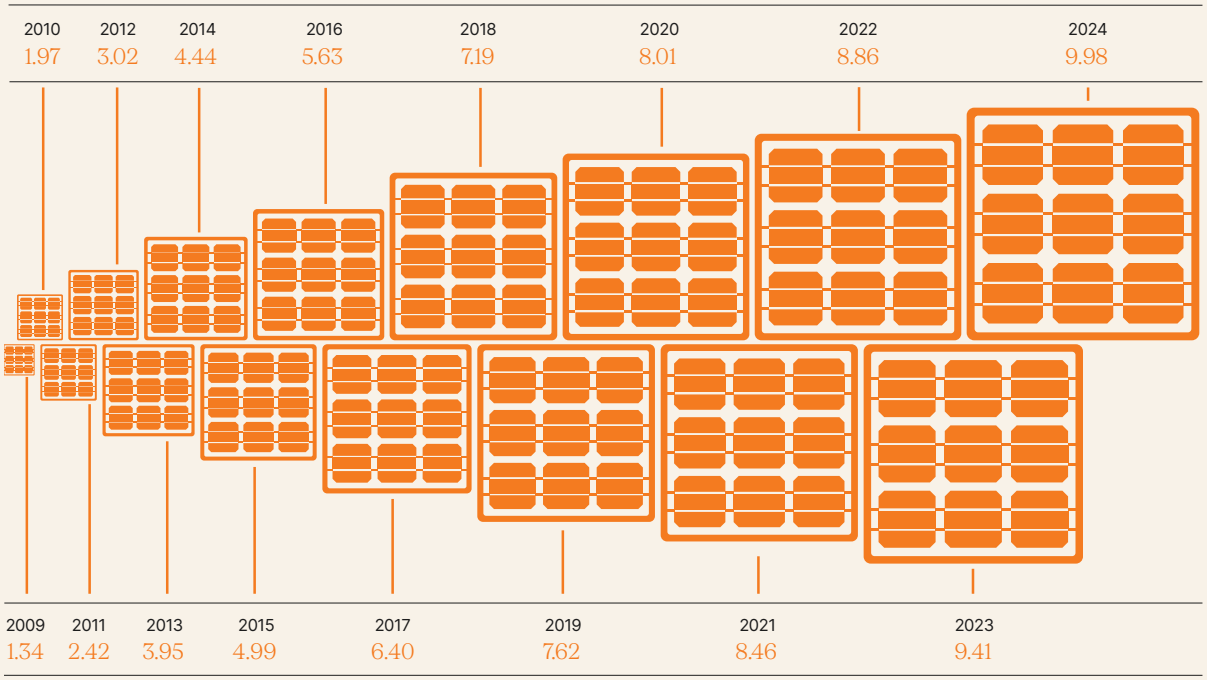


Annual installed capacity of solar PV (MW)



2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
390.22	872.77	1036.13	792.25	800.35	705.97	747.69	1118.80	1617.49	2,65.32	2965.18	3192.85	2793.77	3141.65	3215.24

Average solar PV system size (kW)



Bundaberg Solar Farm
Bundaberg, QLD
Taribelang Country
(Monford Group)

TECHNOLOGY PROFILE

Solar (large-scale)

(Systems larger than 5 MW)

While large-scale solar is down on 2023 in terms of capacity added, the pipeline looks healthy, with new investment commitments significantly up on recent years.

Fourteen large-scale solar projects were commissioned in 2024, totalling 1.2 GW of new capacity. Although the number of new projects commissioned is the same as in 2023, the capacity of those projects is down on 2.1 GW in 2023. The trend in large-scale solar since 2019 has been for strong years to be followed by slower one s – 2024 continued that trend.

Western Australia led the states on large-scale solar projects commissioned, with six, although the combined capacity of those projects was relatively small at 214 MW. Although it only installed three projects in 2024, Queensland added the most capacity, with 385 MW from three projects. Two of those three projects were the second- and third-largest newly commissioned large-scale solar projects in Australia in 2024: the Woolooga Solar Farm and the Wandoan Solar Farm (Stage 1). Queensland also led the states in 2023, commissioning 860 MW from five projects.

The largest project commissioned was BJEI Australia's 330 MW Wellington North Solar Farm in New South Wales. The project is now the third-largest operational solar farm in Australia – see graphic.

Of the 21 renewable energy generation projects completed in Australia in 2024, 14 were large-scale solar developments, six were wind projects, and there was one hybrid solar/wind project.

Of the 59 renewable energy projects under construction as at December 2024, 39 are large-scale solar projects, up from 38 at the same stage in 2023.

1.2 GW

New large-scale solar capacity added in 2024

(2023: 2.1 GW)

9.7 GW

Cumulative large-scale solar capacity in Australia

(2023: 8.5 GW)

16,081 GWh

Generation from solar farms in Australia in 2024

(2023: 14,802 GWh)

The largest solar project in that list is Lightsource BP's 450 MW Goulburn River Solar Farm in Queensland, which was financially committed in 2024.

The Goulburn River Solar Farm was selected as a recipient of a tender in the first round of the Federal

Government's Capacity Investment Scheme in December 2024, and contributed over a third of new financially committed generation capacity for Q4 2024. Twelve of the 19 projects selected in the first round were solar projects, some including a battery storage element. The largest project by capacity is Lightsource BP's 700 MW Sandy Creek Solar Farm in NSW.

The next-biggest solar projects under construction are the same as at this stage last year: BJEI Australia's 300 MW Wellington North Solar Farm and ACEN Renewables' 400 MW Stubbo Solar, both in New South Wales.

In 2023, all five of the largest solar projects in development were in NSW, but ACCIONA's 380 MW Aldoga Solar Farm (committed in 2024) means QLD now has an entry in that list.

Investment pipeline

Thirteen large-scale solar projects reached financial commitment in 2024, for a combined 1.9 GW. Five of those projects will be located each in New South Wales and Victoria. The largest solar project to reach financial commitment was the previously mentioned Goulburn River Solar Farm, which the NSW Government says will power 191,000 homes each year.[1]

Six hybrid projects with solar generation also reached financial commitment in 2024 for a total of 210 MW, meaning total large-scale solar commitments for the year, including hybrid projects, stood at 19 projects for approximately 2.1 GW.

New financial commitments to large-scale solar projects (not including hybrid projects) totalled $1.9 billion, significantly up from $912 million in 2023, and above $1.5 billion in 2022. This is reflective of a very strong year for new investments in utility scale renewable energy. Read more about a stellar year for investment in the 2024 snapshot on page 5.

> Utility scale solar power generation has grown more than 20-fold in the last six years

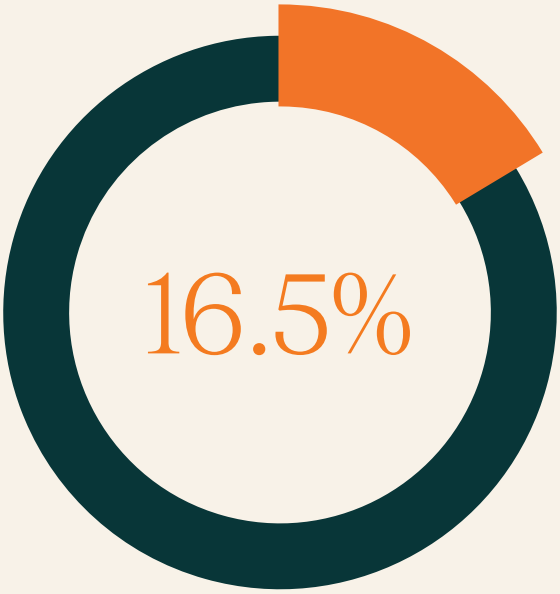
In its Renewables 2024 report, the International Energy Agency (IEA) predicts that Australia will add approximately 53 GW of renewable capacity between 2024 and 2030, almost 65 per cent of which will be solar PV. Of that solar capacity, 55 per cent is forecast to come from utility scale projects. According to the IEA, "expanding state- and federal-level auctions, rising corporate demand and the high competitiveness of solar PV systems drive dynamic renewables growth."[2]

According to figures published by the Department of Climate Change, Energy, the Environment and Water in 2024, utility scale solar power generation has grown more than 20-fold in the last six years.[3] Early signs are that the Capacity Investment Scheme, as the primary Federal mechanism to replace the diminishing incentives of the soon-to-expire Renewable Energy Target, is strengthening investor confidence in large-scale storage projects.

[1] NSW Government, https://www.nsw.gov.au/media-releases/approved-upper-hunter-solar-farm-to-power-191000-homes
[2] International Energy Agency, Renewables 2024
[3] G Heynes, PVTech, https://www.pv-tech.org/australia-large-scale-solar-pv-grows-20-fold-in-six-years/

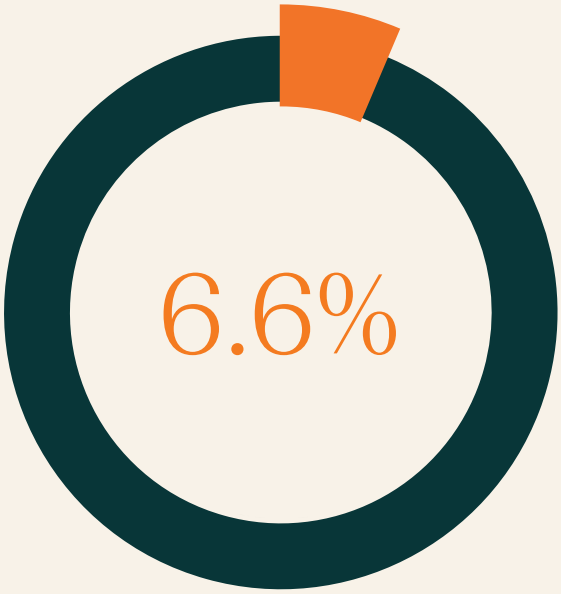
Stubbo Solar
Stubbo, NSW
Wiradjuri Country
(ACEN Australia)

Large-scale solar generation in 2024



of total clean energy generated in Australia in 2023

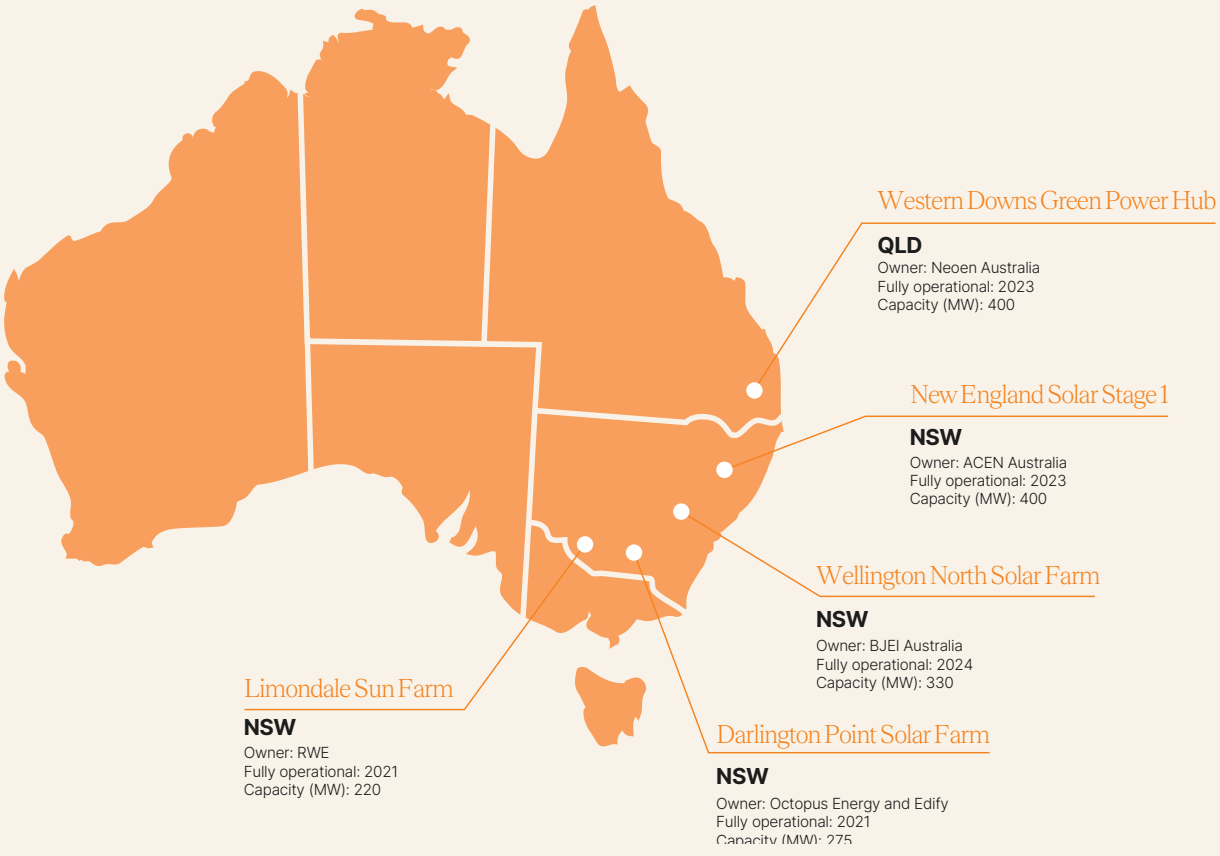
(2023: 15.6%)



of total Australian electricity generated in 2023

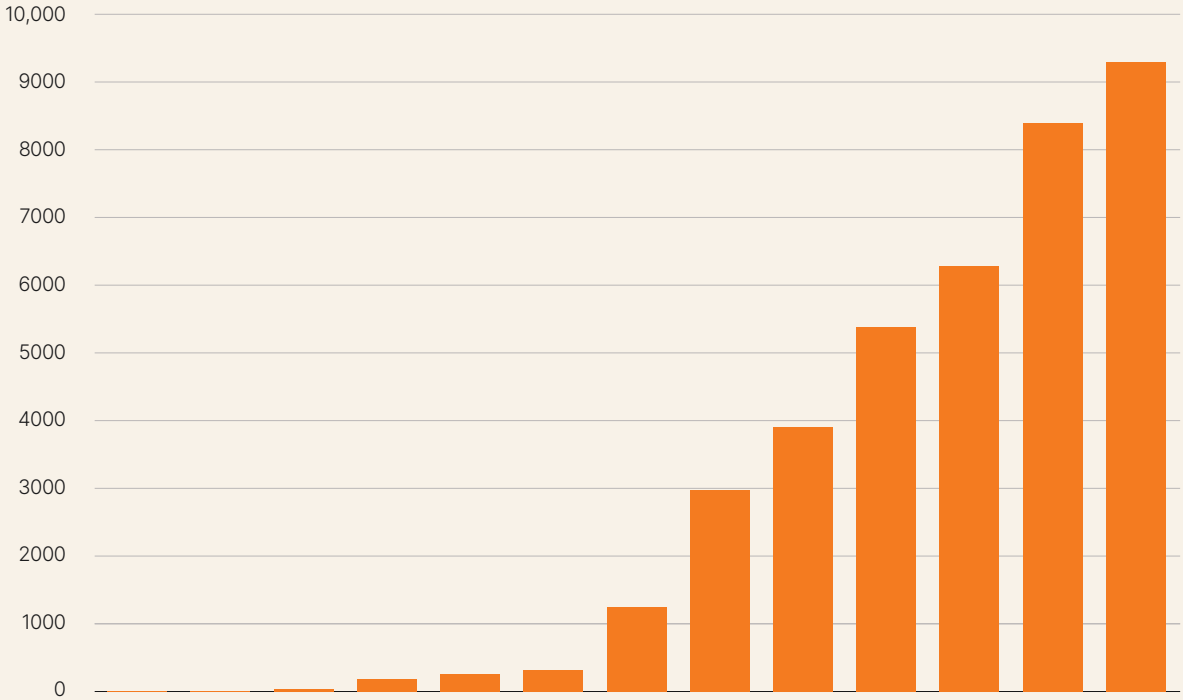
(2023: 6.2%)

Top five Australian solar farms by capacity



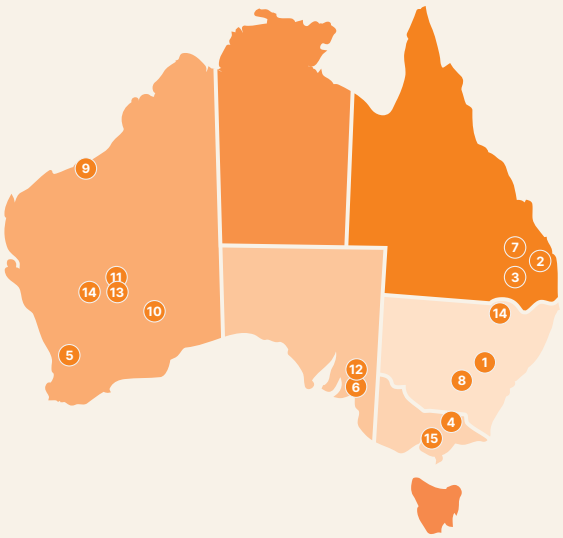
Aldoga Solar Farm
Aldoga, QLD
Bailai, Gurang, Gooreng Gooreng
and Taribelang Bunda Country
(Acciona Energía)

Cumulative installed large-scale solar capacity (MW)



2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
10	10	30	185	264	325	1260	3002	3934	5417.5	6332.7	8452.4	9373.2

Large-scale solar projects commissioned in 2024



1 Wellington North Solar Farm
NSW
Owner: BJEI Australia
Capacity (MW): 330

2 Woolooga Solar Farm
QLD
Owner: Lightsource BP
Capacity (MW): 176

3 Wandoan Solar Farm Stage 1
QLD
Owner: Vena Energy
Capacity (MW): 125

4 Glenrowan Solar Farm
VIC
Owner: Pacific Partnership (CIMIC Group)
Capacity (MW): 102

5 North Star Junction
WA
Owner: Fortescue Metals Group
Capacity (MW): 100

6 Tailem Bend Solar Farm Stage 2
SA
Owner: Vena Energy
Capacity (MW): 87

7 Moura Solar Farm
QLD
Owner: Mytilineos SA
Capacity (MW): 84

8 Wyalong Solar Farm
NSW
Owner: Mytilineos SA
Capacity (MW): 52.5

9 Port Hedland Power Station
WA
Owner: APA Group
Capacity (MW): 45

10 Tropicana Solar Project
WA
Owner: Pacific Energy
Capacity (MW): 24

11 Jundee Solar Project
WA
Owner: Zenith Energy
Capacity (MW): 16.9

12 Mannum Adelaide Pumping Station No 3 (MAPL3)
SA
Owner: South Australia Water Corporation
Capacity (MW): 16.215

13 Kathleen Valley Power Station - Solar
WA
Owner: Zenith Energy
Capacity (MW): 16

14 Bluebird Solar Farm
WA
Owner: Pacific Energy
Capacity (MW) : 12.4

15 Winneke Water Treatment Plant
VIC
Owner: Melbourne Water Corporation
Capacity (MW) : 9

Zenith Energy's Northern Star Resources Jundee Project Wind Farm (Australia's most remote wind farm). Powered by Goldwind
Northern Goldfields, WA
Tjiwarl Country

TECHNOLOGY PROFILE

Wind
(including offshore wind)

Levels of new financial commitments to wind farms had a material uptick in 2024.

Wind generation provided 32.5 GWh of energy in 2024, up from 31.6 GWh in 2023. This is the highest in the Australian renewables sector and is equivalent to powering over seven million homes for an entire year.

Wind power accounted for 33.5 per cent of Australia's renewable power generation in 2024, fractionally down from 33.9 per cent in 2023, which was down on 2022. This is reflective of the growth of other forms of renewable generation, as well as an extended 'wind drought' in early 2024, while the wind sector has also faced a variety of challenges moving projects to completion.

There are multiple contributing factors to this, including uncertainties and inconsistencies in environmental assessments, supply chain challenges, uncertainty in revenue and power-purchase agreements, complexities regarding grid access and many more. These challenges mean the assessment and determination process for onshore wind projects tends to be lengthier and more complex than other technologies.

Meanwhile, wind power provided 13.4 per cent of Australia's total power generation in 2024, which puts it almost exactly level with 2023. While hydropower's percentage contribution fell and solar has grown (albeit by small amounts), the division of renewables in the system compared to 2023 has not changed much.

Six wind farms were connected to the grid in 2024 – one less than 2023. That figure does not include Zenith Energy's Jundee Hybrid Project, a 41 MW hybrid solar/wind development in Western Australia. In terms of generation capacity added, the largest wind farm commissioned in 2024 was Tilt Renewables' 396 MW Rye Park Wind Farm in New South Wales, which is considerably larger than the largest wind farm commissioned in 2023 (244 MW).

6

wind farms commissioned in 2024

(2023: 7)

836 MW

new wind generation capacity added in 2024

(2023: 942 MW)

$5.9 billion

new investment in wind projects in 2024

(2023: $0)

Four of the seven wind projects are located in WA, although in terms of generation capacity added, New South Wales leads the way with 541 MW, and Victoria comes second with 158 MW. Queensland led the way for commissioned wind projects in 2023 but did not energise any projects in 2024.

Four of the five largest wind farms in Australia (by capacity) have been commissioned since 2021

– see map graphic – so while the sector may be experiencing some difficulties getting projects to completion, there is nevertheless considerable progress being made.

Victoria provided 33.2 per cent of Australia's wind generation in 2024 and remains the wind-generation leader among the states and territories. However, its share of Australia's overall wind generation has fallen from 36.2 per cent in 2023, due to increases in output in other states.

New South Wales has overtaken South Australia as the second-highest wind generating state, with 20.4 per cent of Australia's wind generation. South Australi a is in third, at 20.1 per cent. See below for more information on which states are likely to see a bump in wind generation in the years to come.

Of the 59 renewable energy projects under construction as of December 2024, 18 are wind farms, up from 13 at the same point in 2023.

Squadron Energy's Clarke Creek Wind Farm installed its 50th wind turbine in late 2024, reaching the halfway point in its construction,[1] and work continues on what will be the largest wind farm by capacity in Australia, ACCIONA Energia's 923 MW MacIntyre Wind Farm in Queensland.

The two stages of the Golden Plains Wind Farm (756 MW for East and 577 MW for West) also remain under construction in Victoria. The East stage is likely to finish construction at some point in 2026, with the West stage to follow a year or two later.

Wind in the sails

There were eight new financial commitments to large-scale wind projects in 2024, up from zero in 2023, representing a significant uptick for the sector.

Total investment commitments reached approximately $5.9 billion, up from zero in 2024.[2] This was the highest single-year total since the Clean Energy Council began reporting data in 2017, and just ahead of the previous record in 2018, which was $5.8 billion.

The investment was spread across eight projects – four in Queensland, two in Western Australia and one each in New South Wales and Victoria. Those projects, when completed, will amount to 2.2 GW of new generation capacity.

The largest of these projects is Squadron Energy's Uungula Wind Farm in NSW, at 414 MW. The project is slated to include 69 turbines and will be the largest wind farm in NSW when completed.

Also in New South Wales, Stage 1 of Ark Energy's Bowmans Creek Wind Farm, which will generate 335 MW, has received approval to proceed under the *Environmental Protection and Biodiversity Conservation Act*.[3] Stage 2 of the project, which has yet to receive approval, would generate 120 MW. The two stages combined would make the project the largest wind farm in NSW.

Dwarfing both developments would be the proposed Bellwether Wind Farm from ACCIONA Energia in Western Australia, which would have the capacity to generate 3 GW of power. Should that project come to fruition, it would be the largest wind farm outside of China.[4] The project is in the early stages and ACCIONA is currently engaging with local communities. According to ACCIONA, the project would generate around $1 billion in economic benefits and create 400 construction jobs as well as 100 ongoing full-time roles.

In late 2024, the successful projects in the first round of the Federal Government's Capacity Investment Scheme were announced,[5] including six wind projects and one combined wind and battery energy storage system project – Neoen's 585 MW / 800 MWh Junction River wind farm in New South Wales.

The announcement that two South Australian wind farms had received backing – Neoen's 300 MW Goyder North wind farm and Tilt Renewables' 274 MW Palmer Wind Farm – means South Australia is "set to become the first gigawatt-scale grid in the world to reach 100 per cent 'net' renewables, all through wind and solar".[6]

Offshore wind powers up

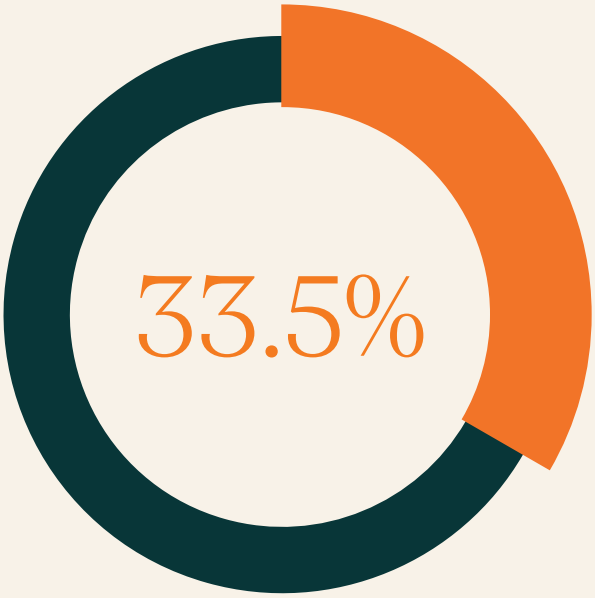
In 2024, the Australian offshore wind industry also saw significant developments, with area declarations, awarding of feasibility licences and increased regulatory support.

Outstanding consultations for proposed offshore wind areas were finalised, with the Southern Ocean, Illawarra, Indian Ocean (Bunbury) and Bass Strait (Northern Tasmania) offshore wind area declaration processes completed in 2024. These four areas join the Gippsland and Hunter offshore wind areas as the six declared areas for future offshore wind operations.

Following the awarding of 12 GW of feasibility licences across six projects in the Gippsland offshore wind area in 2023, an additional six licences were awarded in July 2024 – to the 3 GW Aurora Green project,

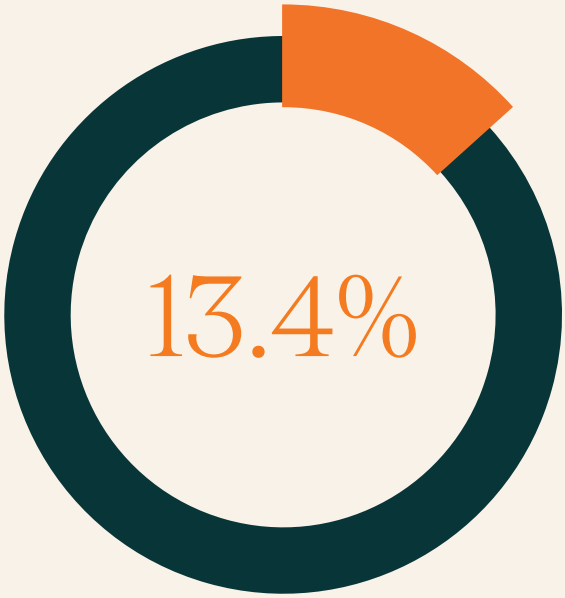
[1] Z Zhang, Ecogeneration, https://www.ecogeneration.com.au/clarke-creek-wind-farm-hits-halfway-mark/
[2] The Uungula wind farm reached financial close in late 2023 but was not publicly announced until 2024, meaning it was not captured in our 2023 data
[3] R Williamson, RenewEconomy, https://reneweconomy.com.au/hunter-valley-wind-farm-gets-federal-approval-as-developer-sets-sights-on-second-stage/
[4] Australian Trade and Investment Commission, https://international.austrade.gov.au/en/news-and-analysis/news/acciona-energia-plans-3-gw-wind-farm-western-australia
[5] Australian Energy Market Operator, https://aemoservices.com.au/en/tenders/cis-tender-1-generation-nem
[6] G Parkinson, RenewEconomy, https://reneweconomy.com.au/cis-auction-wins-esnure-south-australia-will-be-first-grid-in-world-to-reach-100-pct-net-wind-and-solar/

Wind power generation in 2023



of total clean energy generated in Australia in 2024

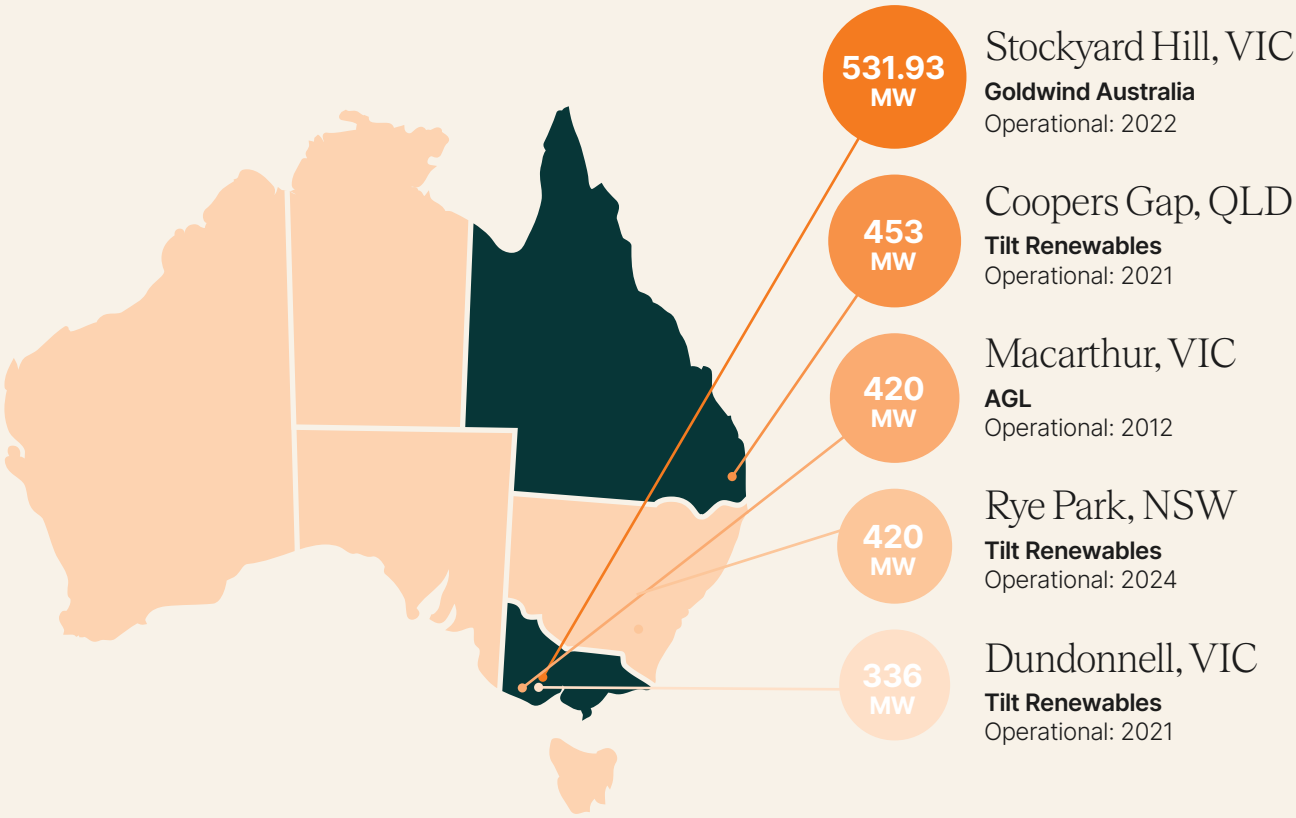
(2023: 33.9%)



of total Australian electricity generated in 2024

(2023: 13.4%)

5 largest wind farms in Australia by capacity (MW)



2.1 GW Greater Gippsland project, 1.5 GW Navigator North project, 2 GW (approximate) Kent Offshore Wind project, 2.5 GW Great Eastern Offshore Wind Farm project, and 2 GW Gippsland 2 project. This brings total capacity of feasibility licences awarded in the Gippsland offshore wind area to 25 GW.

With licences secured, early survey works commenced for several projects in the Gippsland region, such as geophysical and bird surveys. Outcomes from these will contribute to proponents' environmental impact assessments and, ultimately, applications for commercial licences to construct and operate offshore wind farms.

Additionally, in early 2025, the Federal Minister for Climate Change and Energy made formal offers for feasibility licences in the Hunter offshore wind area for the 2 GW Novocastrian project, and in the Southern Ocean offshore wind area for the 1 GW+ Spinifex project. Pending these offers being accepted, this will bring the total capacity of projects awarded feasibility licences in Australia to over 28 GW.

The Federal Department of Climate Change, Energy and the Environment published its Offshore Electricity Infrastructure Amendment Regulations 2024 in December, which enable the Offshore Electricity Infrastructure Act 2021. These regulations detail how proponents can carry out feasibility studies, prepare management plans, and requirements for project design.

Victorian offshore wind

Following its announcement in 2022 of a 9 GW offshore wind target (2 GW by 2032, 4 GW by 2035, 9 GW by 2040), Victoria legislated the target under the Climate Change and Energy Legislation Amendment (Renewable Energy and Storage Targets) Act 2024 in March. This makes Victoria the only government in Australia with an offshore wind target.

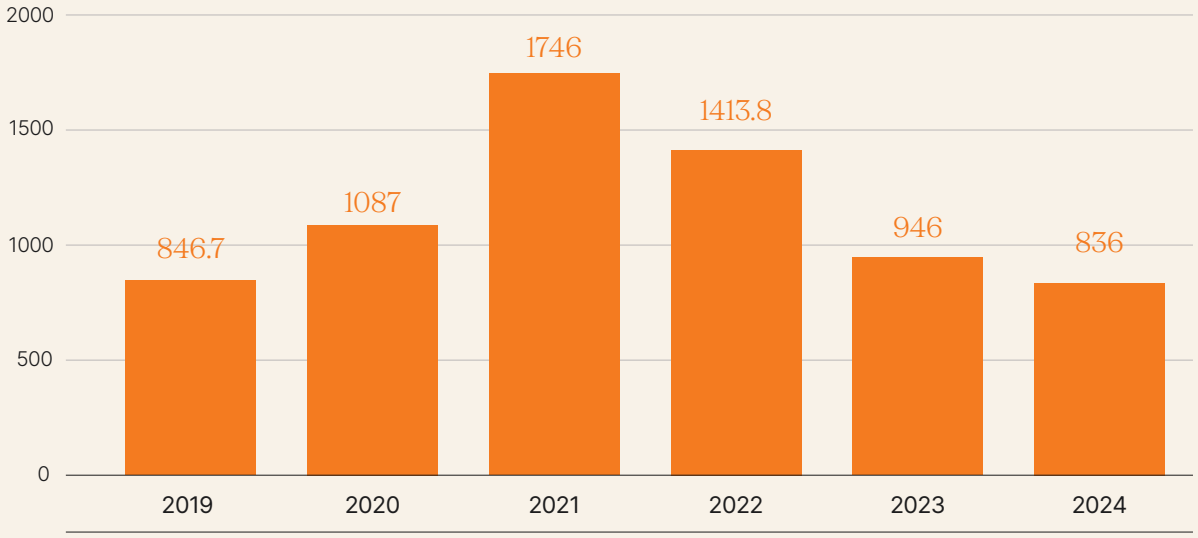
In December, VicGrid, which is responsible for the development of shore connection points for Victorian offshore wind areas, opened a tender process seeking a public-private partnership for delivery of Gippsland's transmission infrastructure requirements. This would include a development partner to design, build, finance, operate and maintain the transmission lines and connection hub to connect projects developed in the Gippsland offshore wind area into the National Electricity Market.

The expression of interest process for the Victorian Government's first 2 GW offshore wind auction round, which was originally slated for Q4 2024, is expected in the first quarter of 2025.

Wind farms under construction or financially committed as at end of 2024

Commitment year	Project	Lead operator-owner	State	Location	Installed Capacity (MW)
2022	MacIntyre Wind Farm	Acciona	QLD	Karara	923
2022	Golden Plains Wind Farm East	TagEnergy & Ingka Group	VIC	Rokewood	756
2024	Golden Plains Wind Farm - Stage 2	TagEnergy & Ingka Group	VIC	Rokewood	577
2022	Clarke Creek Wind Farm Stage 1	Squadron Energy	QLD	Clarke Creek	450
2023	Uungula Wind Farm	Squadron Energy	NSW	Yarragal	414
2024	Lotus Creek Wind Farm	CS Energy	QLD	Lotus Creek	285
2024	Diamondy Wind Farm (Wambo) Stage 2	Stanwell and Cubico Sustainable Investments	QLD	Diamondy	254.2
2022	Diamondy Wind Farm (Wambo) Stage 1	Stanwell and Cubico Sustainable Investments	QLD	Diamondy	252
2024	Boulder Creek Wind Farm	CS Energy	QLD	Boulder Creek	228
2020	Ryan Corner Wind Farm	Global Power Generation	VIC	Port Fairy	218
2022	Goyder South Wind Farm 1A	Neoen Australia	SA	Burra	209
2022	Goyder South Wind Farm 1B	Neoen Australia	SA	Burra	203
2024	Warradarge Wind Farm Stage 2	Bright Energy Investments	WA	Warradarge	108
2024	King Rocks Wind Farm	Synergy	WA	Hyden	105
2020	Hawkesdale Wind Farm	Global Power Generation	VIC	Hawkesdale	96.6
2021	Crookwell 3 Wind Farm	Global Power Generation	NSW	Goulburn	58
2024	St Ives Wind Project	Gold Fields	WA	Kambalda	42
2024	Mt Weld Power Station - Wind	Zenith Energy	WA	Laverton	24

Annual installed wind capacity in Australia (MW)



Percentage of Australia's wind generation by state

TAS	QLD	WA	NSW	SA	VIC
5.8%	9%	11.5%	20.1%	20.4%	33.2%

MacIntyre Wind Farm
Warwick, QLD
Githabul Country
(Acciona Energía)

CASE STUDY

Generation underway at MacIntyre Wind Farm

ACCIONA Energia is developing three renewable energy projects that will form part of the Southern Downs Renewable Energy Zone in southern Queensland. Those three projects form the 'MacIntyre Wind Precinct' and include the MacIntyre Wind Farm, Herries Range Wind Farm, and Karara Battery. The latter two are all currently in the proposal stage.

The most advanced is the 923 MW MacIntyre Wind Farm, which when complete will be the largest wind farm in Australia by capacity, the largest wind farm in the southern hemisphere, and one of the largest onshore wind farms in the world. During the construction phase, the project has inducted more than 5,016 workers and will permanently employ approximately 40 staff during its operational life. The project has announced that at least 2 per cent of project work hours will be performed by persons who identify as Aboriginal or Torres Strait Islander. Impressively, the MacIntyre Wind Farm has already surpassed this goal, with 4% of total work hours contributed by these communities.

"The MacIntyre First Nations Small Grants Program aims to support community-led initiatives that celebrate and sustain the rich and diverse First Nations cultures in our project community," says Matt Moncrieff, First Nations Engagement Manager at ACCIONA Energia. "As a First Nations man, I am proud see how ACCIONA Energía is committed to exploring and collaborating with First Nations groups on initiatives that go beyond participation, procurement and employment. We recognise the importance of supporting community development, caring for Country, education, and cultural heritage initiatives within the regions where we operate."

In October 2024, 27 of the wind farm's turbines were connected to the grid, for a total installed capacity of 154 MW. The project will host 162 wind turbines and is expected to be fully operational by the end of 2025. The asset will be powering an equivalent 700,000 homes with renewable electricity.

About the Clean Energy Council

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, hydrogen and emerging technologies along with more than 8,500 solar and battery storage installers.

We are committed to accelerating the transformation of Australia's energy system to one that is smarter and cleaner. The Clean Energy Council leads and supports the growth of the clean energy industry in Australia by:

- **providing a strong voice for our members**
- **standing up for the industry**
- **developing and driving effective policy and advocacy**
- **working with industry to continually improve standards and maintain integrity**
- **working closely with local, state and federal governments to increase demand for clean energy products**
- **providing services and initiatives to members and the wider industry that help to grow the sector**
- **promoting the clean energy industry.**

In 2024 we welcomed:

191

new members

77

event partners

Clean Energy Council members are companies who work in or support the clean energy sector. They join to receive various member benefits such as getting the latest industry updates, networking opportunities, contributing expertise to key industry discussions and having a central voice to represent the sector.

A special thank you to our sponsoring members. They are industry leaders at the forefront of influence and innovation. They take an active role in the Clean Energy Council through policy and advocacy initiatives and have access to key industry engagement opportunities.

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2024 highlights

JAN

FEB

MAR

APR

MAY

JUN

JUL

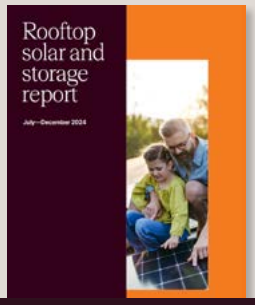
AUG

SEP

OCT

NOV

DEC



Published the first edition of our bi-annual *Rooftop Solar and Storage Report*, using data from SunWiz

Published the report, *The Future of Long-duration Energy Storage*, providing a comprehensive overview of how different storage technologies could keep costs down and firm renewables as the transition progresses.

Celebrated 10 years of the Australian Wind Industry Summit, welcoming more than 700 engaged and passionate attendees. The format will be shaken up in 2025, with the Australian Onshore Wind Industry Forum in May and the Australian Offshore Wind Industry Forum in June.

Published two industry leading reports: *Billions in the Bush*, on the economic benefits clean energy is delivering to farmers and regional communities across Australia, and *Emissions Reductions Delivered by Renewable Energy*, highlighting the CO2 emissions reduction in Australia since renewables began to enter the grid.

Published *Leading Practice Principles: First Nations and Renewable Energy Projects*, a guide for industry engagement and partnership with Traditional Owners based on principles drawn up by the First Nations Clean Energy Network

Following its successful launch in 2023, our Careers for Net Zero initiative with the Energy Efficiency Council went on the road to three locations in Queensland, showcasing the many career opportunities that will help deliver a prosperous, net-zero emissions Australia.

The Clean Energy Regulator appointed the Clean Energy Council as the product listing body for small-scale renewables, including solar panels and inverters, allowing us to continue doing essential work to provide certainty for industry and ensure consumers have access to safe and reliable products.

Published reports on our website to support our Best Practice Charter, a voluntary set of commitments for Clean Energy Council members outlining the standards signatories will uphold in the development of current and new clean energy projects.

Thank you

The Clean Energy Council would like to thank Green Energy Markets, the Business Renewables Centre Australia and Bioenergy Australia for their contributions to this year's *Clean Energy Australia*, and the following members and industry stakeholders for providing photographs:

Acciona
ACEN Australia
Akaysha
Genex Power
Goldwind
Monford Group
Neoen
Pacific Hydro
Spark Renewables
Squadron Energy
X-ELIO

Projects are classified as having reached construction commitment based on the date that the commitment is announced publicly.

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MacIntyre Wind Farm
Warwick, QLD
Gidhabal Country
(Acciona Energía)

CLEAN ENERGY COUNCIL

Level 20, 180 Lonsdale Street
Melbourne VIC Australia 3000

+61 3 9929 4100
info@cleanenergycouncil.org.au

cleanenergycouncil.org.au

Tropicana Wind Farm
Great Victoria Desert, WA
Wongatha Country
(Pacific Energy)
Pacific Energy's Tropicana wind farm is powered by Goldwind wind turbines