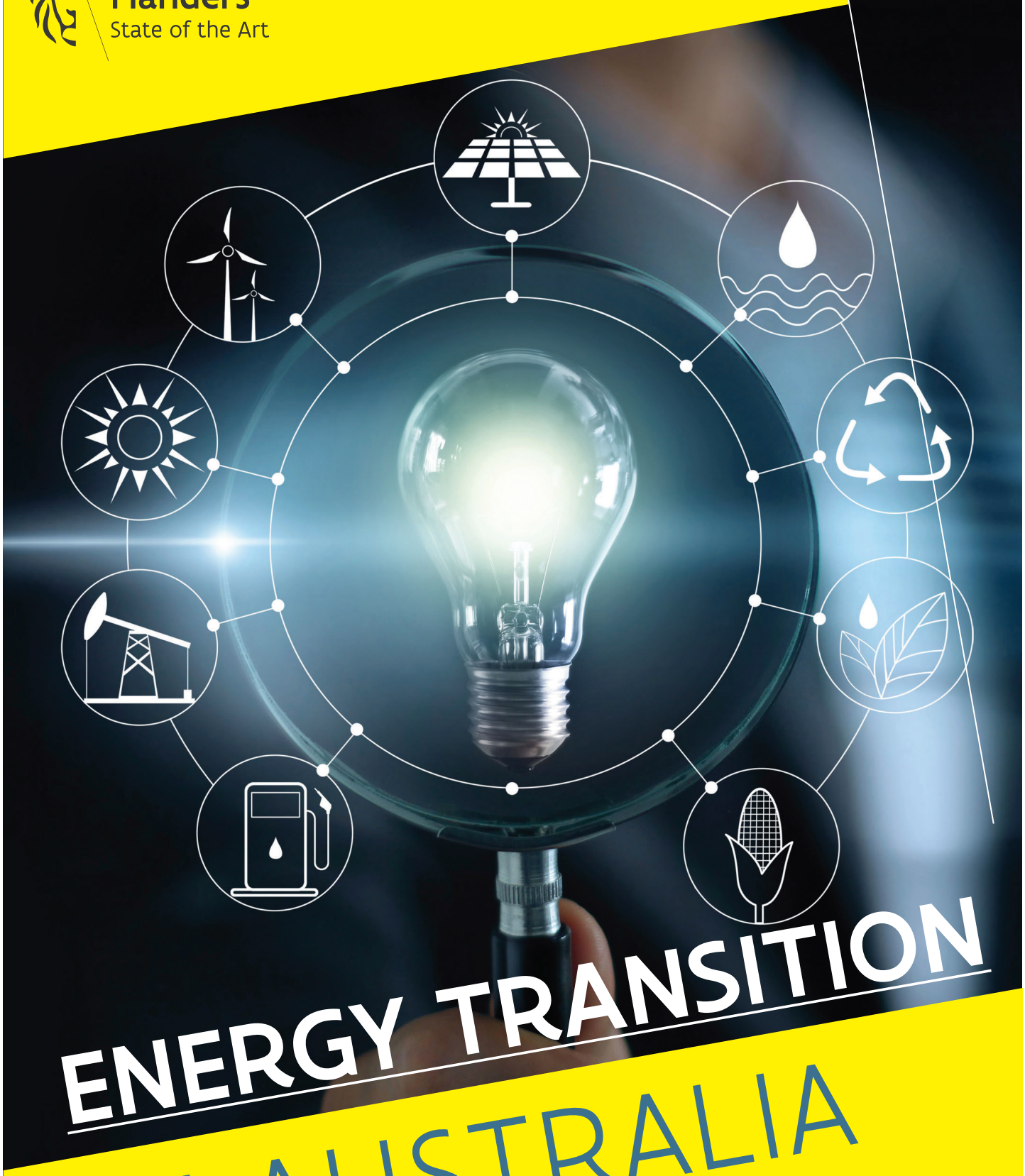
Flanders
State of the Art



ENERGY TRANSITION IN AUSTRALIA

FLANDERS INVESTMENT & TRADE MARKET SURVEY

FLANDERS
INVESTMENT &
TRADE

Market Study

ENERGY TRANSITION IN AUSTRALIA

State of Play 2020

Flanders Investment & Trade Autstralia Pty Ltd
103/838 Collins Street
Docklands VIC 3008
Australia
T. +61 3 96 14 09 80
E. melbourne@fitagency.com

TABLE OF CONTENTS

1. FOREWORD

As fossil fuel electricity generation is a highly emissions-intensive process, it has prompted the Federal Government to intervene in the industry, with also several State Governments implementing renewable energy policies. At the Federal level, political difficulty has led to several failed attempts to regulate the industry over the past years: these attempts include the carbon tax, the Finkel Review clean energy target and the National Energy Guarantee. However, in May 2020 the Government finally released the discussion papers for a national Energy Technology Investment Roadmap that will drive investment in low emissions technologies.

Australia's supply mix, networks and wholesale market need to undergo a significant and well-planned transition to harness the potential economic benefits of moving to a more reliable and a more renewable future. Failure to reform the energy market to ensure key energy infrastructure investment decisions are made in the short term could push Australia into a disruptive energy future.

In general, demand for fossil fuel electricity generation (above all black coal and brown coal) is in structural, but slow decline: the rising cost efficiency of renewable forms of energy, staunch environmental opposition to new coal mines and regulatory changes regarding carbon emissions are all significant impediments to the industry's growth. Investment in new fossil fuel generation plants has waned over the past five years due to regulatory uncertainty, while most new generation investment has been directed to wind and solar plants. Furthermore, energy usage per capita has fallen over the past decade due to increased energy efficiency of appliances, the uptake of photovoltaic solar panels and other measures, which have reduced long-term demand for fossil fuel generated power.

Energy was firmly on the agenda at the May 2019 federal election, with the two major political parties taking up vastly different positions on energy and climate change. A notable shift in public sentiment occurred towards the end of 2019 as devasting bushfires swept across much of the country. Pressure mounted on the government to acknowledge the growing impact of climate change and take meaningful action to reduce Australia's carbon emissions.

With regard to renewable energy, 2019 was another year of extraordinary growth as State governments, industry and communities embraced the transition. There were 34 large-scale projects completed in 2019, increasing Australia's large-scale renewable energy capacity by 2.2 GW and generating $4.3 billion in investment. Renewable energy was responsible for 21% of Australia's total electricity generation in 2019, an increase of 2% on 2018. For a brief period, renewables passed the 50% mark of total generation in the National Electricity Market in November.

The wind sector had its best ever year in 2019, with 837 MW of capacity added across 8 new wind farms. For the first time, wind overtook hydro as Australia's leading clean energy source, accounting for more than 35% of Australia's renewable energy generation.
Records were also broken across the board in solar as the large, medium and rooftop sectors installed more capacity than ever before. The large-scale solar sector saw 1,416 MW of new capacity added in 2019 across 27 solar farms, while the rooftop solar industry smashed last year's record of 1.6 GW to break the 2 GW milestone for the first time.
Hydro power contributed 25.7% of Australia's renewable energy generation.

However, despite all the records broken in 2019, ongoing uncertainty threatens to slow the industry's momentum: lack of a confirmed national energy policy on top of transmission and connection challenges resulted in new investment commitments falling by around 50% in 2019, from $10.7 billion in 2018 to just $4.5 billion in 2019.

Some of the challenges currently affecting the industry can be linked to the fact that transmission investment has failed to keep pace with the industry's rapid growth. If left unresolved, these issues threaten to undermine investment confidence and severely slow the construction of much needed new clean energy capacity.

Australian States and Territories continued to fill the gap of a Federal policy in 2019. The ACT became just the eighth major jurisdiction in the world to generate 100% of its energy from renewable sources, while South Australia continues to push ahead with its renewable transition, as more than 50% of the State's electricity came from renewables in 2019 and it is now aiming to source 100% of its power from clean energy by 2030.

The hydrogen industry made significant progress in 2019, with the Council of Australian Governments Energy Council agreeing in November to back $370 million of hydrogen projects under the National Hydrogen Strategy. The outlook for green hydrogen is positive also because it is included in the Energy Technology Investment Roadmap discussion papers as one of the "candidates" to deliver the Government's "technology, not taxes" approach to reducing emissions.

[For information related to Australian stakeholders and companies operating in the Energy industry, please contact FIT Melbourne]

1.1 COVID-19 IMPACT

The coal mining industry is expected to be significantly affected by the consequences from COVID-19. China is one of the largest export markets for Australian coal, where it is primarily used in the production of steel. Quarantine measures in China and throughout the global economy have disrupted supply chains, hindering manufacturing activity and lowering demand for steel. As a result, China is expected to demand less black coal from Australia in 2020, leading to a decline in export prices. China may also seek to increase reliance on its own coal production, in an effort to stimulate its economy amid a downturn from COVID-19. The capacity for Australian exporters to redirect sales to alternative markets is limited, particularly given the ongoing shift towards renewable energy sources.

Over the long term, a significant decline in oil prices associated with the outbreak of COVID-19 may cause demand for coal to decline, as oil and coal are partial substitutes in energy generation. Despite a probable recovery in the global economy as the effects of COVID-19 fades, oil prices may remain low for an extended period.

Restrictions implemented in response to the COVID-19 virus outbreak are altering demand for industry services. The closure of many businesses and growth in the number of Australian's working from home due to social distancing regulations have led to a drop in demand from commercial clients. Therefore the slowdown in the domestic manufacturing sector is reducing demand for electricity.

The drop in the domestic price of natural gas is expected to encourage consumers to use gas products over those requiring electricity. However, natural gas is an imperfect substitute for electricity, as it can only be used for heating and cooking purposes.

Overall, the decline in the electricity service price is expected to reduce returns on investment for renewable electricity projects, and contribute to increased demand for fossil fuel electricity.

2. AUSTRALIAN MACRO-FACTOR ANALYSIS

To gain a better understanding of the Australian Energy industry, a preliminary overview of local key macro-factors is useful to understand the demographics of the population and the financial status (before COVID-19 impact) that influences the interest for and adoption of new sources of energy.

2.1 DEMOGRAPHIC FACTORS

As at 30 September 2019, Australia's preliminary estimated resident population (ERP) amounted to 25,464,116 people. The annual growth was 371,100 people (1.5%): 37.5% was due to natural increase, and 62.5% was due to net overseas migration.

Annual population change by state and territory

	Population at 30 Sep 2019 '000	Change over previous year '000	Change over previous year %
New South Wales	8 118.0	102.0	1.3
Victoria	6 629.9	129.6	2.0
Queensland	5 115.5	84.7	1.7
South Australia	1 756.5	15.4	0.9
Western Australia	2 630.6	29.3	1.1
Tasmania	535.5	5.3	1.0
Northern Territory	245.6	-1.4	–0.6
Australian Capital Territory	428.1	6.2	1.5
Australia (a)	**25 464.1**	**371.1**	**1.5**

Australia's ERP 31/12/2019 (Australian Bureau of Statistics, 2019)

Despite the fact that Australia is a vast geographical area, approx. 90% of Australian population lives in urban areas, with 67% living in capital cities:

Capital city	Change over 2018-19 Number	Per cent	Population at 30 Jun 2019 Number
Melbourne	113,500	2.3	5,078,200
Sydney	87,100	1.7	5,312,200
Brisbane	52,600	2.1	2,514,200
Perth	27,400	1.3	2,086,000
Adelaide	13,900	1.0	1,359,800
Canberra	6,300	1.5	426,700
Hobart	3,400	1.5	236,100
Darwin	-1,100	-0.8	147,300
All capital cities	**303,100**	**1.8**	**17,160,400**

Australia's Regional Population Growth 2018-2019 (Australian Bureau of Statistics, 2019)

Just over 17 million people live in Australia's capitals (+303,100 people during 2018-19). Capital city growth accounted for 79% of Australia's total population increase in the year ending 30 June 2019.
Melbourne's population grew by 113,500 to reach 5 million residents during 2018-19. This was the largest growth for any capital city, and was followed by Sydney (up 87,100 people), Brisbane (52,600) and Perth (27,400). Melbourne also had the highest growth rate (2.3%), ahead of Brisbane (2.1%) and Sydney (1.7%).

The population of Australia consists of a unique composition. In 2018, there were 7.3 million migrants living in Australia. This means that 29% of the population was born abroad. The majority of the migrants are born in the following countries: a] England - 992,000 people; b] China - 651,000 people; c] India - 592,000 people; d] New Zealand - 568,000 people.

The median age of the Australian population has increased by two years over the last two decades, from 35 years at 30 June 1998 to 37 years at 30 June 2019.
Australians live longer than ever before, but half of the population lives with at least one chronic condition. Many of these chronic conditions such as overweight and obesity, insufficient physical activity and alcohol consumption are related to lifestyle factors.

2.2 ECONOMIC FACTORS

Australian GDP has grown for the last 28 years, with a growth rate above the OECD average, confirming the successful transition from the largest resources and mining investment boom in Australian history to a broader-based growth. Official data reveals that GDP growth reflected the strong performance of 15 out of 20 industries, with Health and Education (13% industry share of output), Mining (10%), Finance (9%), Construction (8%) and Manufacturing (6%) and professional scientific and technical services performing greatly.

- Estimated GDP of $1.89 trillion as of 2019 (14th GDP global rank), with estimated growth of 1.7% in 2019. For 2020, due to the recent bushfires and the restrictive measures related to COVID-19, the expectation is of a recession with the Q1 down by 0,3% and a much steeper drop in Q2. IMF projected a 6,7% GDP contraction for 2020 (and a 6,1% increase in 2021)
- Official cash rate 0.25% (following recent Australia's central bank cut due to COVID-19)
- Unemployment rate 6.2% (this is unfortunately predicted to grow by the end of 2020)
- Inflation rate 2.2%
- Average weekly earnings $1,257 with a household saving ratio of 5.5%

https://rba.gov.au/snapshots/economy-indicators-snapshot/ (Reserve Bank of Australia, 10 June 2020)

Exchange rate Euro: 0.6146 (in Units of foreign currencies per Australian dollar) on 2 July 2020)
https://rba.gov.au/statistics/frequency/exchange-rates.html

The Australian cost of living stands as one of the highest with a Consumer Price Index (CPI) of USD 110 (in Belgium USD 104): as a practical example, compared to an USD 123 value shopping basket in Australia, you can buy the same products in Belgium for only USD 100 (approx. € 115 versus € 93). This is also an indication of the Purchasing Power, which is worth USD 1.45 in Australia and USD 0.8 in Belgium (OECD, 2017).

Australia's political stability, transparent regulatory system, and sound governance frameworks underpin its economic resilience. Ranked in the global top five on the Index of Economic Freedom, Australia's effective governance provides multinationals with a safe, secure business environment, offering:

- A business environment that is ranked 15th out of 190 economies for ease of doing business;
- A robust regulatory system noted for its strong finance and banking regulations;
- A competitive remuneration for professionals;
- A high purchasing power;
- A quality of life that is rated the 7th highest in the world.

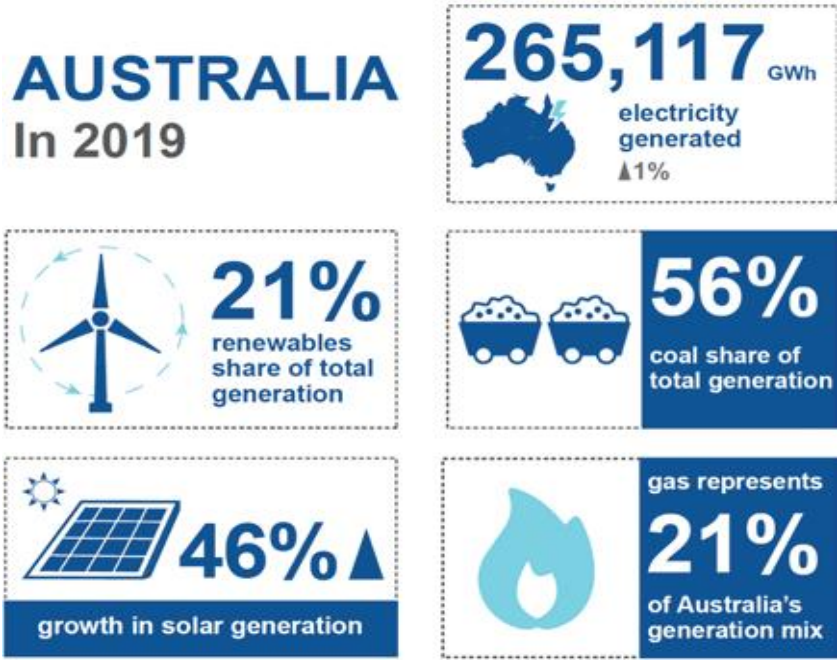
3. ENERGY MARKET (GENERAL STATISTICS - SNAPSHOT)

3.1 ENERGY GENERATION

According to the latest official release from the Department of Industry, Science, Energy and Resources providing estimates for 2018-19 and calendar year 2019, total electricity generation (including by power plants and by businesses and households for their own use) was estimated to be 265,117 GWh.

Fossil fuel sources contributed 209,636 GWh (79%) of total electricity generation in 2019, a decrease of 2% compared with 2018. Nevertheless, the data demonstrate the importance of coal-fired generation, which continues to be an essential part of Australia's energy mix, representing 56% of total generation in 2019. Gas-fired generation grew to account for 21%, driven largely by growth in New South Wales, Victoria and South Australia.

Renewable sources contributed 55,481 GWh (21%) of total electricity generation in 2019, an increase of 2% compared with 2018. The largest source of renewable generation was wind (7% of total generation, proportionally up 19% on 2018) followed by solar (7%, with large-scale solar presenting the largest increase up 135%, followed by small-scale solar up 25%, in addition to solar rooftops) and hydro (5%).



3.2 ENERGY CONSUMPTION

Electricity consumption is the percentage of electricity that is consumed nationally, and is measured in petajoule (Government of Australia, 2019). According to the latest Australian Energy Statistics (September 2019), Australia's energy consumption rose by 0.9% (52 petajoules) in 2017–18 to reach 6,172 petajoules. This compares with average growth of 0.6% a year over the past ten years.

3.3 ENERGY COSTS

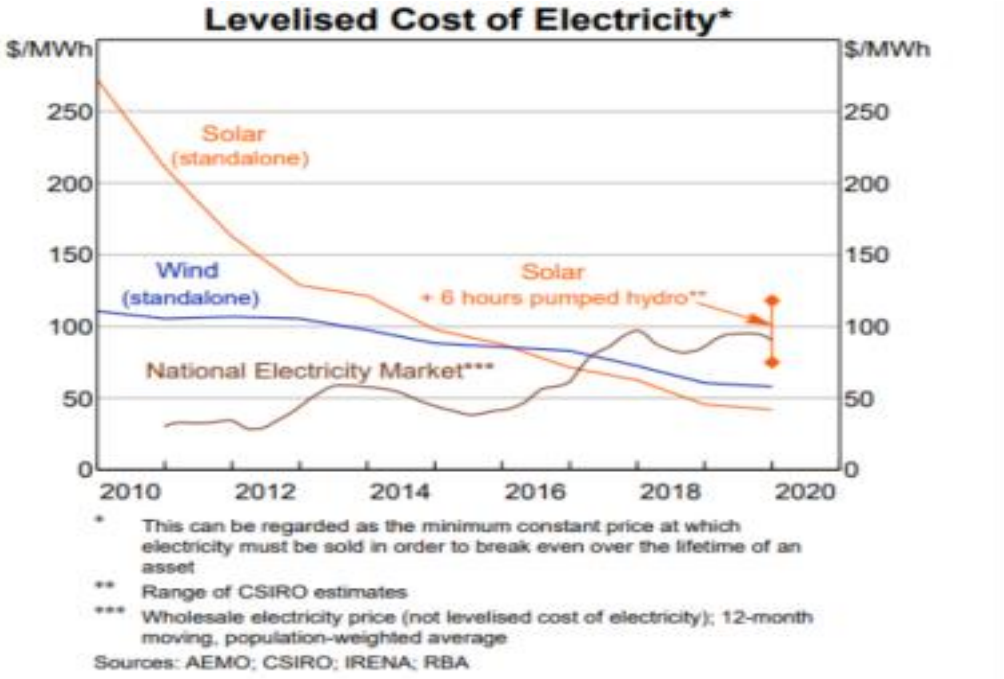
Network prices vary between regions and cover the cost of a vast array of services designed to ensure the safe and reliable supply of energy to households and businesses. The other components of energy bills are wholesale costs, retail charges and environmental costs.

Gas and electricity network prices have been falling across the country since 2015: average electricity network prices are down more than 13% and gas distribution prices fell 10% between 2015 and 2017 to make up 35% of an average residential gas bill.

In May 2020 wholesale electricity prices across the National Electricity Market fell to their lowest as gas prices continued on the downward path established in 2019. The dedicated webpage of Australian Energy Market Operator indicates current average price of electricity in the NEM.

The downward trend was the direct result of reduced costs for gas and coal generators, which meant they could offer electricity into the wholesale market at lower prices. There was also an increase in the amount of low priced solar generation coming into the market.

Levelized cost of electricity are transitioning, but they have been presenting a decreasing trend in the last ten years, with the expectation that it will generally continue in the next ten as well.



Source: Reserve Bank of Australia, 'Renewable Energy Investment in Australia' – Bulletin March 2020

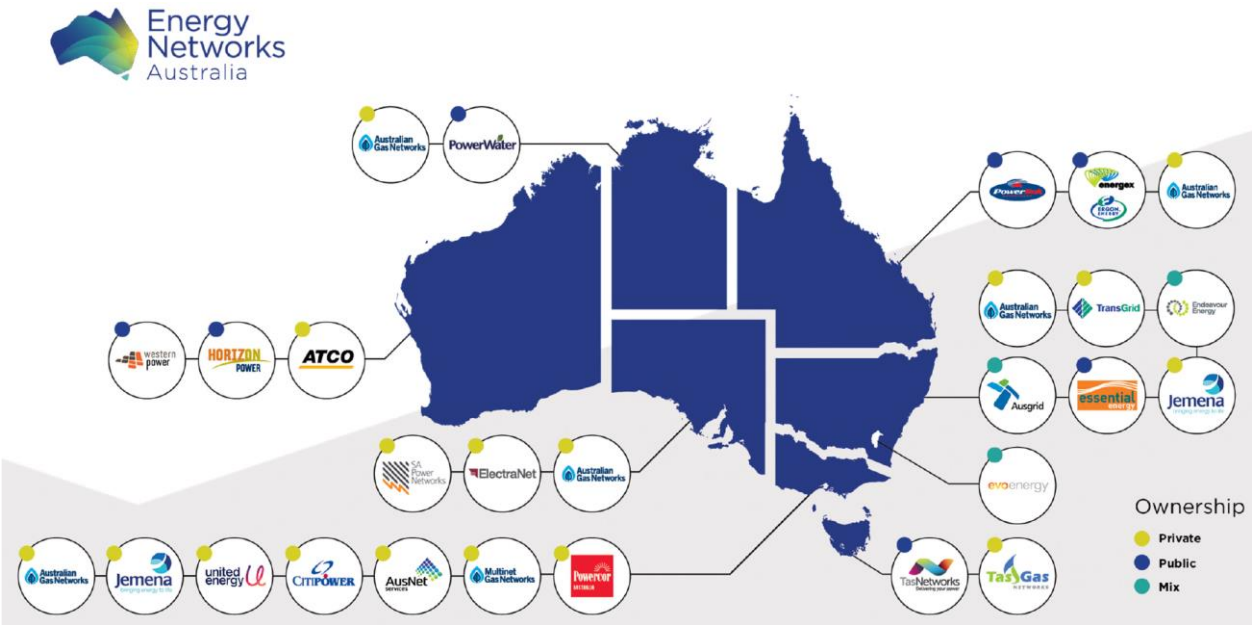
4. ENERGY DISTRIBUTION

4.1 ENERGY NETWORKS

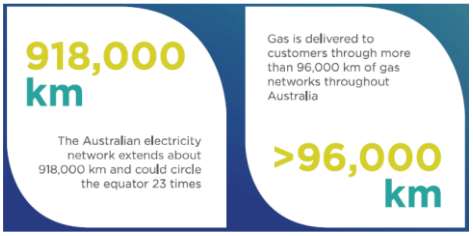
Australia's energy networks comprise the transmission towers, substations, poles, wires and pipes which supply gas and electricity to almost every household and business in the country. This vital infrastructure is owned and managed by a mix of private and government-owned organisations which are responsible for the security and reliability of Australia's energy supplies.

The energy network evolved into the National Electricity Market (NEM) that was created in 1995, following the formal adoption by the Council of Australian Governments of a national competition policy. The previously vertically integrated generation, transmission, distribution and retail functions were separated. The generation and retail sectors transitioned to competitive markets and the transmission and distribution businesses became regulated.
Only Western Australia and Northern Territory remain separate from the interconnected NEM.

There are 22 electricity and gas network businesses in Australia with a mix of public and private ownership. Australian energy networks are natural monopolies subject to strict economic regulation.
In most cases, they are governed by the National Electricity Rules which are made by the Australian Energy Market Commission under the National Electricity Laws. All major Australian gas networks are governed by National Gas Rules.



The revenue most energy networks are allowed to earn (and therefore the prices they charge) is governed by the Australian Energy Regulator and is set every five years. Western Australia has a similar structure regulated by its Economic Regulation Authority.



4.2 ELECTRICITY TRANSMISSION

Transmission networks transport high-voltage electricity from generators to distribution networks and directly to large industrial users. Transmission networks are highly regulated geographic monopolies, with only one major enterprise in each state. The Australian Energy Regulator oversees most of the industry's operations and sets revenue determinations for five-year periods for individual entities. The AER uses forecast network expansion requirements, existing networks' maintenance needs and the rate of return for industry players to make revenue determinations.

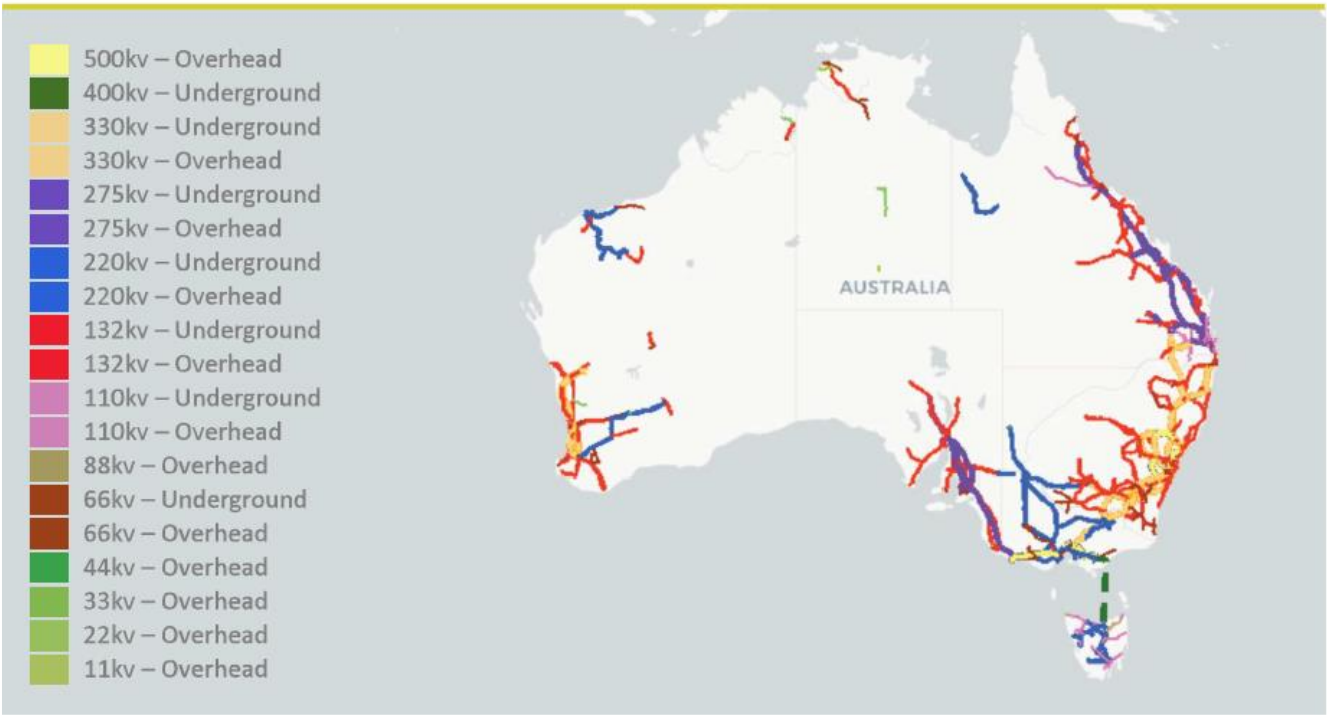
As demand for centrally generated electricity has declined over the past five years, due to the rollout of energy efficiency programs and greater household use of solar panels, the AER has responded by reducing the maximum allowed revenue for many industry operators. Industry revenue decreased at an annualised 3.5% over the five years through 2018-19, to $3 billion.

Key Statistics Snapshot	Total Revenue 2019	Annual Growth 2014-2019	Annual Growth 2019-2024
	$3.0bn	**-3.5%**	**-1.1%**

Industry revenue is anticipated to stabilise with the AER allowing for moderate revenue growth for most industry players. However, revenue is projected to decline significantly in 2022-23 and 2023-24 as the AER has announced its intention to cut maximum allowed revenue in the next round of revenue determinations. Industry revenue is projected to decline at an annualised 1.1% over the five years through 2023-24, to $2.9 billion.

Thanks to the connection of the networks of the Australian states, now the East coast can benefit from the longest interconnected electricity system in the world.

Australia's transmission networks



Competitive landscape

The Electricity Transmission industry exhibits high market share concentration, with the industry's four largest players, Powerlink, TransGrid, AusNet Services and ElectraNet, accounting for over 80% of total revenue. Industry participation is limited by the narrow scope of industry services, the extremely high costs associated with establishing new electricity transmission assets, and the government regulation and ownership of existing assets. As the industry's main assets are natural monopolies, each state only has one service provider. As a result, market share concentration has remained steady.

4.3 ELECTRICITY DISTRIBUTION

Australian distribution networks are built and regulated to ensure a safe and reliable supply of electricity, even during peak demand periods in summer. Network operators have extended their networks substantially over the past decade, to account for potential rises in peak electricity demand. Regulators allow industry operators to generate a return on their capital so they can pay debt and equity holders. Historically, the amount of revenue that regulators have permitted the industry to capture from users has been proportional to the size of the industry's capital base. Industry revenue decreased at an annualised 2.3% over the five years through 2018-19, and it declined by 1.7%, to $14.4 billion, in 2019.

Key Statistics Snapshot	Total Revenue 2019	Annual Growth 2014-2019	Annual Growth 2019-2024
	$14.4bn	**-2.3%**	**1.7%**

The industry is projected to continue changing over the next five years. New AER revenue determinations and regulatory periods will be introduced, influencing industry revenue for monopoly electricity distributors. The uptake of solar panels among households and potential improvements in battery technology will likely reduce demand for centrally generated electricity. Investment in distribution networks is anticipated to shift as a result of changes to the AER's reliability targets. Industry revenue is projected to increase at an annualised 1.7% over the five years through 2023-24, to $15.7 billion.

Competitive landscape

The industry displays a moderate level of market share concentration. In 2018-19, the industry's four largest players accounted for over 60% of total revenue. State and Territory Governments still play a large role in electricity distribution and industry operators are structured to cater to specific geographic areas. This trend limits the market share that any company can hold in the industry, while also resulting in a small number of medium-sized operators.

Moderate privatisation limits the industry's market share concentration, as many industry assets cannot be acquired. Victoria and South Australia have privatised their distribution networks by selling and leasing former State Government assets. In these States, joint ownership structures also obscure concentration in these markets. Although six networks operate in Victoria and New South Wales, three entities dominate these states. The Queensland State Government's merger of Ergon Energy and ENERGEX into a single entity has increased market share concentration in the industry over the past five years.

[For the list of the major Electricity Transmission and Distribution Networks, please contact FIT Melbourne]

4.4 ELECTRICITY (AND GAS) RETAILING

4.4.1 Electricity retailing

Industry revenue rose significantly over the two years through 2017-18, due to an increase in operators passing on purchase costs to customers. Rising gas costs due to the liquefied natural gas export boom in Queensland have contributed to increased gas-fired generation costs over the past five years.

Several power stations across Victoria and South Australia closing down, along with a period of uncertainty reducing investment in replacing power plants, caused wholesale prices to spike across the National Electricity Market in the Eastern and Southern parts of Australia. Industry revenue decreased by 4.9% in 2018-19 as supply tensions eased and wholesale prices declined. Overall, revenue rose at an annualised 2.2% over the five years through 2018-19, to $46.6 billion.

Key Statistics Snapshot	Total Revenue 2019	Annual Growth 2014-2019	Annual Growth 2019-2024
	$46.6bn	**2.2%**	**-2.6%**

Industry revenue is forecast to decline over the next five years, as pressure on wholesale prices will likely ease. However, shifting regulation and policy in the industry and in related sectors is likely to create an uncertain operating environment. Resuming carbon pricing or introducing an emissions trading scheme would likely drive up both electricity prices and industry revenue. Increased household uptake of solar panels may also present a challenge for electricity retailers, because demand for and consumption of electricity from the grid would be likely to decline as a result. Overall, industry revenue is projected to fall at an annualised 2.6% over the five years through 2023-24, to $40.7 billion.

Major markets:

- Commercial and services 37,2%
- Households 33,7%
- Manufacturers 24,6%
- Other 4,5%

Competitive landscape

Large, vertically integrated energy companies dominate the industry, with no standalone or second-tier retailers generating more than 5% of industry revenue. Standalone retailers tend to be based on state-owned or formerly State-owned generation and distribution businesses that have expanded into retailing. Examples include Aurora Energy in Tasmania and ActewAGL, a joint venture operating in the Australian Capital Territory. New South Wales' Red Energy operates in multiple States, as does Melbourne-based Simply Energy. Small retail-only participants are mostly active in Victorian and South Australian markets.

4.4.2 Gas Retailing

The industry is expected to grow at an annualised 0.7% over the five years through 2019-20, to $11.5 billion. This growth is primarily due to domestic gas prices rising over the three years through 2018-19. The development of LNG export facilities (please read Chapter 5.2) in the first half of the past five years has caused a significant share of Australian gas production to be shipped overseas. As a result, domestic supply on the Eastern seaboard has been threatened by LNG exporters.

This trend has led to significant price growth. However gas prices are decreasing in 2020, due to growth in global supply and regulation in Western Australia that imposed minimum domestic supply volumes. In 2019-20, industry revenue is forecast to fall by 3%.

Key Statistics Snapshot	Total Revenue 2020	Annual Growth 2015-2020	Annual Growth 2020-2025
	$11.5bn	**0.7%**	**-0.2%**

The domestic price of natural gas is expected to rise slightly over the next five years. As domestic prices usually ease as gas supply rises, LNG exporters are anticipated to continue to allocate a greater share of production for the domestic market, in an effort to prevent market intervention by the Federal Government. Domestic consumption of natural gas is forecast to decline as households transition to more energy-efficient technologies. In addition, demand from gas-fired power stations is also forecast to decline as renewable energy infrastructure is developed. Industry revenue is forecast to decline at an annualised 0.2% over the five years through 2024-25, to $11.4 billion.

Competitive landscape

In terms of gas retail, industry concentration is at medium level. The three largest energy companies, AGL Energy, Origin Energy and EnergyAustralia dominate the Eastern seaboard, providing bundled gas and electricity packages. In contrast, industry concentration in gas distribution is at a high level, a consequence of the natural monopoly characteristics of capital-intensive distribution networks.

Overall, the gas supply industry has a moderate level of concentration, with the largest four players controlling approximately 54% of the market. This share has increased over the past five years due to acquisitions and growth in customer numbers among the major players. This trend is projected to continue as the major players increase their market shares further. The industry is more concentrated within particular geographic regions due to limited numbers of industry operators.

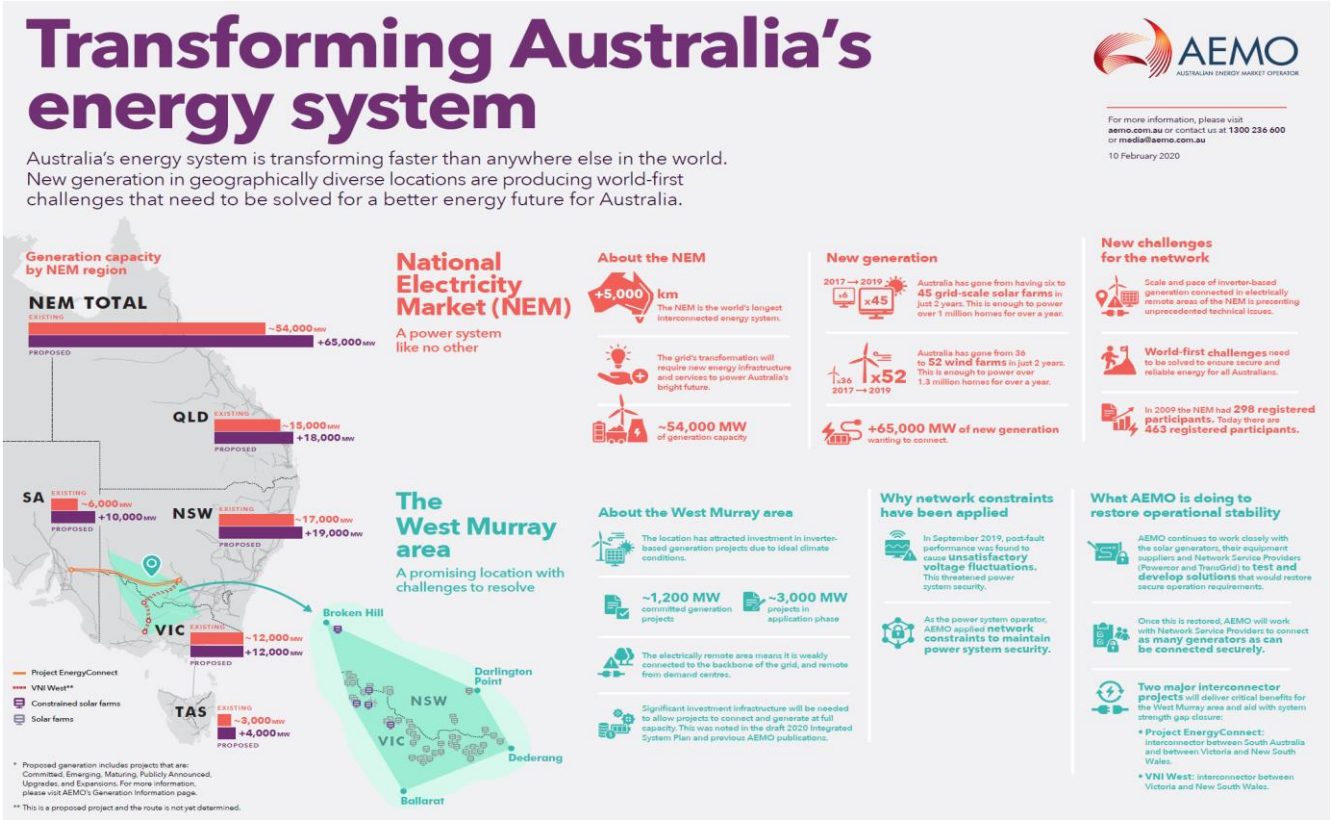
[For the list of the major Electricity and Gas Retailing companies, please contact FIT Melbourne]

4.5 EVOLUTION OF THE ENERGY GRID

As ageing coal-fired generation is retired, it will increasingly be replaced by wind and solar in different locations. Updated transmission networks will be needed to move power around the system locally and interstate, as increasing the capacity of existing transmission interconnectors or high voltage lines can lead to more customers accessing cheaper and more reliable electricity.

Reform in the transmission network access would help in avoiding blackouts and unplanned failure events (i.e. the repeated problems with the Basslink interconnector between Tasmania and Victoria in 2015 and 2019), providing generators with greater certainty that they will be able to export energy (projecting profitability not at risk), and reducing the financial and risk burden on consumers in funding new transmission investments.

The Australian energy system is evolving fast as new generation in geographically diverse locations is producing challenges coming from decentralization, with a possible shift from synchronous to non-synchronous generation.



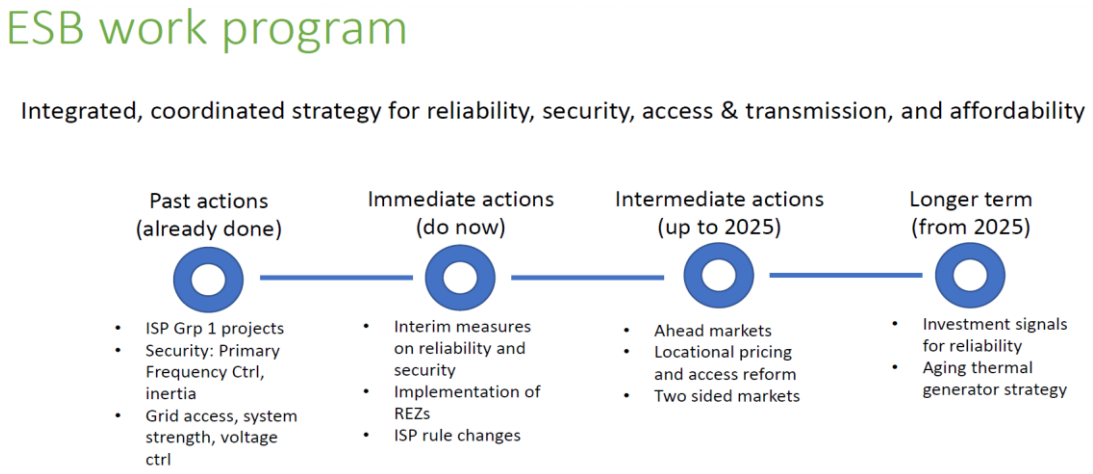
4.5.1 Integrated System Plan (AEMO)

As the nature of electricity generation changes with the integration of smaller but more numerous renewable generators, the transmission network has not kept pace with the transition. Therefore 2019 saw a heightened focus on how the transmission network could be transformed in accordance with the evolving electricity system.

The Australian Energy Market Operator manages electricity and gas systems and markets across Australia, and it is responsible for the Integrated System Plan: the ISP is a whole-of-system plan that provides an integrated roadmap for the efficient development of the National Electricity Market over the next 20 years. It takes into consideration the opportunities provided from existing technologies and anticipated innovations in Distributed Energy Resources, large-scale generation, networks and coupled sectors such as gas and transport.
Intended to be updated every two years, AEMO released a draft 2020 ISP in December 2019 that details tranches of transmission development with key highlights being:

- Nationally significant and essential investments are necessary in the electricity system
- Distributed energy generation capacity expected to double or even triple by 2040
- Over 30 GW of new grid-scale renewables needed by 2040
- Approx. 15 GW or 63% of coal-fired generation will reach end of life and likely retire by 2040
- 5 - 21 GW of new dispatchable resources are necessary to support the new grid-scale renewables by 2040

To support turning the ISP into action, the Energy Security Board (ESB) has developed a set of reforms to the National Electricity Rules intended to streamline the regulatory processes for key transmission projects identified in the ISP.



The ESB consulted on these 'actioning the ISP' rules throughout 2019 and intends to present the rules package to the COAG Energy Council in 2020 for approval.

Simultaneously with this work on the ISP, there are several regulatory approval processes recently completed or underway for transmission upgrades and new interconnectors. Regulatory approval processes have been completed for the Western Victoria Transmission Network Project and Project EnergyConnect, a new interconnector between South Australia and NSW. Regulatory approval processes are also currently underway for minor updates to the existing Queensland to NSW interconnector, Victoria to NSW interconnector and the Marinus Link, the second cable connecting Victoria to Tasmania. Moreover, the Victorian Government has introduced legislation that will allow it to fast-track projects like grid-scale batteries and transmission updates.

In late 2019, the Federal Government announced a new $1 billion Grid Reliability Fund to be administered by the Clean Energy Finance Corporation (a corporate Commonwealth Entity with the unique role to increase investment in Australia's transition to lower emissions): the fund can be used to support transmission infrastructure, as well as new energy generation and storage.

5. FOSSIL ENERGY

5.1 BLACK COAL

Australia is one of the world's lowest cost producers and a major black coal exporter. Domestic reserves exceed domestic demand, are high grade and economical to access. As a result, exports account for a large share of industry revenue, that increased at an annualised 10.4% over the five years through 2018-19. Tighter production regulations in China contributed to world coking prices increasing over the three years through 2018-19. Australia's proximity to key export markets, such as China, India and Japan, and abundance of high-grade metallurgical coal resources, enabled the industry to benefit from this trend. Industry revenue grew by 10.2% in 2018-19, to $78.9 billion.

Key Statistics Snapshot	Total Revenue 2019	Annual Growth 2014-2019	Annual Growth 2019-2024
	$78.9bn	**10.4%**	**-5.9%**

Industry revenue is projected to decline over the next five years. Competition from Colombia, South Africa and Indonesia is anticipated to intensify over the period, as these countries increase export volumes of black coal. Domestic demand is also anticipated to decline over the next five years, as firms in the "fossil fuel electricity generation" industry move towards renewable energy alternatives. Despite this, the Australian Dollar is projected to remain low over the next five years, which will likely keep Australian black coal affordable in export markets and benefit the industry's competitive position. Overall, industry revenue is forecast to fall at an annualised 5.9% over the five years through 2023-24, to $58.1 billion.

Major markets:

- Coking coal export 53%
- Steaming coal export 33,2%
- Domestic electricity generators 11,6%
- Other domestic industries 1,2%

Competitive landscape

The largest players in the Black Coal Mining industry are multinational companies that generally operate in many industries across the Mining division. Several other companies with a market share of less than 5% operate in the industry, including Anglo American Australia, Peabody Energy, and Whitehaven Coal. Additional market share is attributable to players that maintain stakes in industry establishments, but do not operate them, such as Mitsubishi Corporation that has a significant interest in the industry through its stakes coal mines that are operated by BHP Group.

5.1 BROWN COAL

Deposits in Australia are abundant, cheap to access and occur so close to the earth's surface that some industry participants use bulldozers to clear away overburden.

As it stands, the Brown Coal Mining industry's activities are limited to supplying the fossil fuel electricity generation industry. Miners have been unable to develop export markets, as brown coal is too heavy, unstable and low in energy value to make it economically viable to transport overseas. Brown coal also has limited use in other domestic applications. The industry's major players are vertically integrated mine operators and electricity generators that operate power stations located close to their coal mines. The industry's revenue fell at an annualised 9.2% over the five years through 2018-19, to $658.2 million.

Key Statistics Snapshot	Total Revenue 2019	Annual Growth 2014-2019	Annual Growth 2019-2024
	$658.2m	**-9.2%**	**-0.6%**

Demand for brown coal in the downstream fossil fuel electricity generation industry is projected to remain subdued over the next five years. As a result, industry revenue is forecast to decline at an annualised 0.5% over the five years through 2023-24, to $640.3 million.

Competitive landscape

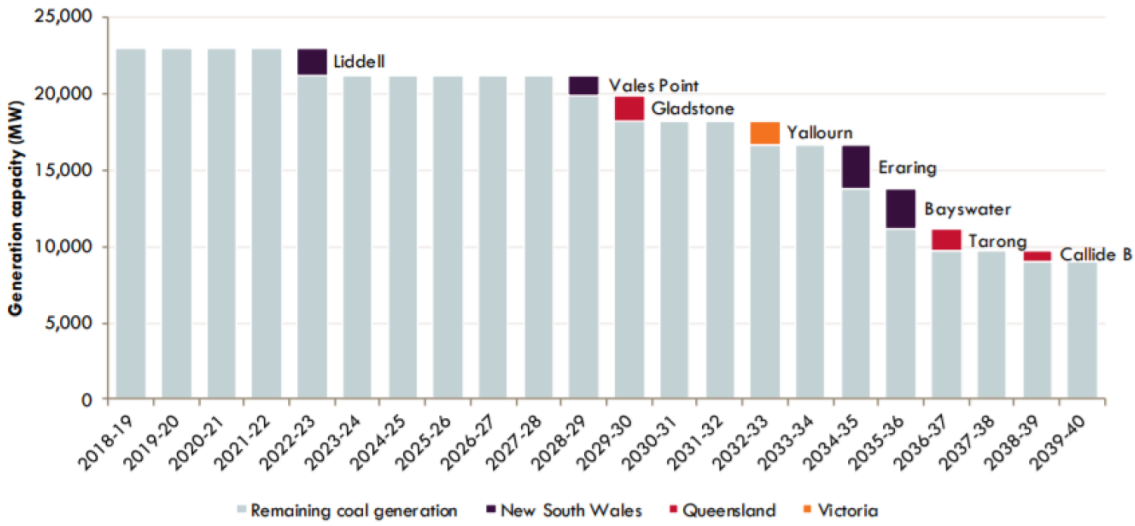
The industry displays a high market share concentration. Five enterprises operated brown coal mines in Australia over the period, until Alcoa, Alinta Power and Engie exited the industry. Two Victorian mine operators and power generators, AGL Energy and EnergyAustralia, now account for all brown coal output in Australia.

[For the list of the major companies involved with Black and Brown Coal, please contact FIT Melbourne]

5.1.1 Coal-fired electricity generation

The Australian electricity system was founded on centralised, carbon-intensive coal-fired generation.
The average lifetime of a coal powered plant is 29 years although its design life is 40 to 50 years. About three-quarters of Australia's coal-fired power stations are operating beyond their original design life and some have had extensive refits. Since 2016, 2.8 GW of coal capacity has retired including Victoria's Hazelwood Power Station, decommissioned in 2017 because it was not economically viable and had reached the end of its productive life. In early 2019, AGL's generator at Loy Yang A brown coal-fired power station unexpectedly tripped offline. It is also expected that Yallourn power station could close much sooner than its scheduled 2032 retirement.

According to Australian Energy Market Operator's Integrated System Plan (Chapter 4.5.1), it is expected that 14 GW of coal-fired generation will reach the end of its technical life and retire by 2040, as shown in the figure below. Those retiring currently generate 70 TWh, which is equivalent to one-third of current total National Electricity Market consumption.



National Electricity Market: coal plant closures (coal-fired generation remaining as power stations retire)
Source: Australian Energy Market Operator

The closure of some coal plants creates the possibility to diverse supply resources, shifting from a centralized network to a decentralized one, eventually allowing for a greater opportunity for renewable energy.

5.2 LIQUEFIED NATURAL GAS

Australian liquefied natural gas (LNG) exports have increased from 15.4 million tonnes in 2009-10 to an estimated 74.8 million tonnes in 2019-20. Industry revenue has increased at an annualised 23.8% over the five years through 2019-20, to total $53.6 billion.

Key Statistics Snapshot	Total Revenue 2020	Annual Growth 2015-2020	Annual Growth 2020-2025
	$53.6bn	23.8%	-1.6%

The wave of project development that occurred across the industry over the past decade has now concluded. Ten LNG facilities are operational in 2020, including the Prelude and Ichthys projects, which shipped their first cargoes in 2018-19. Together, the industry's ten LNG projects have an annual nameplate capacity of 88 million tonnes per year. Industry revenue increased by 6.4% in 2019, as the Prelude and Ichthys projects ramp up production.

A collapse in LNG export prices has affected the industry over the past five years, causing losses over the two years through 2015-16. Profit has since improved as global LNG prices recovered. Lower export prices have particularly affected establishments in Queensland, which rely on more expensive coal seam gas extraction.

In 2019-20, Australia reached the end of a massive boom that resulted in over $200 billion of investment in LNG projects over the past decade. The first LNG project in Australia was the North West Shelf project, which was completed in 1989 and is currently operated by Woodside Petroleum.

Global demand for LNG is forecast to continue increasing over the long term, as developed economies transition towards renewable energy. Natural gas is an ideal fuel for use with intermittent renewable generation, as it can be quickly dispatched, is easily transported, and emits less than half of the emissions of coal-based power. Industry revenue is projected to decrease at an annualised 1.6% over the five years through 2024-25, to $49.5 billion. Increased LNG production from other countries is anticipated to increase external competition.

Major destination markets:

- Japan 53%
- China 33,2%
- South Korea 11,6%
- Other 1,2%
- Singapore 1%

Competitive landscape

The industry's major players operate eight of the ten industry establishments. The final two projects are the APLNG LNG project, which is operated by Origin Energy Limited, and the GLNG project, which is operated by Santos Ltd. Origin owns 37.5% of the APLNG project, which has a nameplate capacity of 9 million tonnes. Santos owns 30% of the GLNG project, which has a nameplate capacity of 7.8 million tonnes. Due to the minor share of ownership by Origin and Santos, the total industry market shares of these companies are below 5%.

Although the industry's seven players operate all industry establishments, only 66.7% of the revenue generated by these facilities is attributable to these players. The remaining 33.3% is attributable to minor joint venture partners that own stakes in LNG facilities, but do not operate in any capacity. Most of these joint venture partners are subsidiaries of LNG customers in the Asian market.

5.3 PETROLEUM

Crude oil purchase costs, in conjunction with fluctuations in the value of the Australian dollar, contributes to significant revenue volatility. Declines in refinery output and surging import penetration have negatively affected the industry over the past five years. Consequently, industry revenue is expected to decline at an annualised 2.3% over the five years through 2019-20, to $20.5 billion. This includes an anticipated revenue decline of 3.5% in 2020, partly due to falling crude oil prices. The industry's productive capacity has significantly declined over the past decade.

Key Statistics Snapshot	Total Revenue 2020	Annual Growth 2015-2020	Annual Growth 2020-2025
	$20.5bn	**-2.3%**	**-0.6%**

The industry competes with imported refined fuel products for shares of end markets, and has lost ground progressively over the past decade. Sophisticated refineries that have opened in the Asia-Pacific region have outperformed many Australian firms due to their greater scale, lower costs and more favourable regulatory environment. These competitors have been producing fuel that meets Australian standards, eroding a traditional barrier to entry for foreign-refined.

The industry's performance is forecast to slightly decline over the next five years. Imports are projected to grow over the period and offset these price increases. Industry profit margins are anticipated to remain low, but are likely to slightly increase as underperforming firms continue leaving the industry. Industry revenue is forecast to decrease at an annualised 0.6% over the five years through 2024-25, to $19.9 billion. Revenue declines for the Petroleum Refining and Petroleum Fuel Manufacturing industry is expected to be revised down significantly in 2020 due to the world price of crude oil plummeting because of COVID-19 related restrictions.

Major products:

- Automotive petroleum 38,3%
- Diesel 31%
- Aviation turbine fuel 13,6%
- Other 17,1%

Competitive landscape

While the four major players dominate the industry, multiple small firms also operate in the industry. However, the revenue generated by these firms is expected to account for less than 5% of industry revenue in 2020. These firms are typically located in remote areas, where producing fuel is more economical than transporting it from national distributors.

[For the list of the major companies involved with LNG and Petroleum, please contact FIT Melbourne]

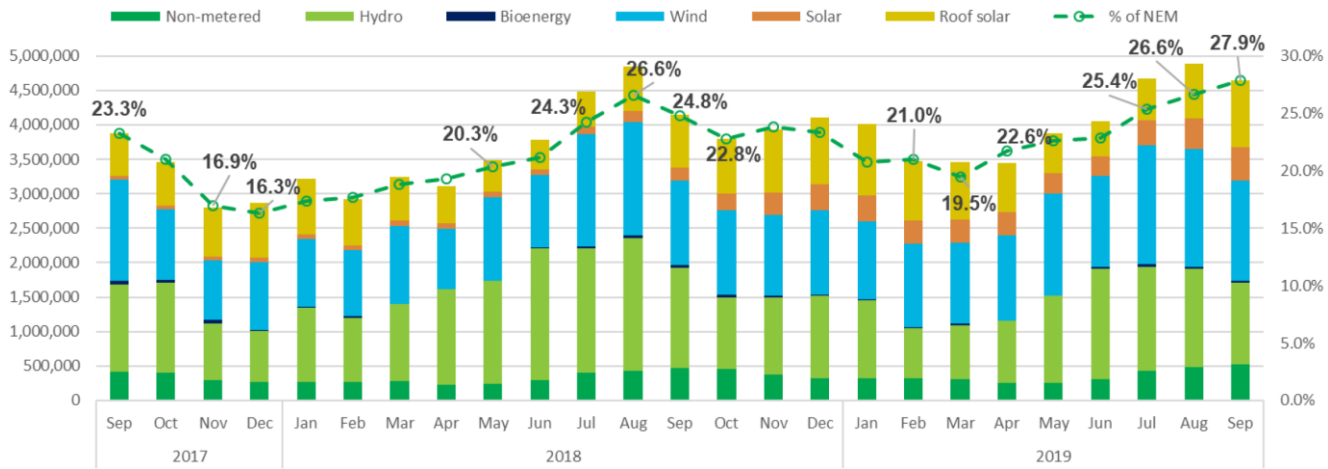
6. RENEWABLE ENERGY

6.1 OVERVIEW

Another year of extraordinary growth saw records tumble in 2019 as State Governments, industry and communities embraced the transition to clean energy. Australia's large-scale renewable energy capacity increased by 2.2 GW across 34 projects in 2019, with large-scale solar making up more than two-thirds of this new capacity. The rooftop solar juggernaut also continued as the industry's 2.2 GW of installed capacity smashed the previous year's record of 1.6 GW. This extra capacity increased renewable energy's contribution to Australia's total electricity generation to 24% (annual average 2019-2020), a growth of 2.7% on 2018.

For the first time, wind overtook hydro as Australia's leading clean energy source, accounting for more than 35% of Australia's renewable energy generation, as 837 MW of new capacity was installed across eight new wind farms. Hydro power was second, contributing 25.7%. This was lower than previous years due to the ongoing impact of the drought in eastern Australia and the massive growth experienced by wind and solar.

At the end of 2019, 11.1 GW of new generation was under construction or financially committed, representing $20.4 billion in investment and more than 14,500 jobs



Source: Green Energy Markets (All-Energy Australia, October 2019)

6.1.1 Renewable Energy Target

The Renewable Energy Target is an Australian Government scheme designed to reduce emissions of greenhouse gases in the electricity sector and encourage the additional generation of electricity from sustainable and renewable sources.

The Renewable Energy Target works by allowing both large-scale power stations and the owners of small-scale systems to create large-scale generation certificates and small-scale technology certificates for every MW/h of power they generate. Certificates are then purchased by electricity retailers (who supply electricity to householders and businesses) and submitted to the Clean Energy Regulator to meet the retailers' legal obligations under the Renewable Energy Target. This creates a market which provides financial incentives to both large-scale renewable energy power stations and the owners of small-scale renewable energy systems.

Small-scale technology certificates can be created following the installation of an eligible system, and are calculated based on the amount of electricity a system produces or replaces (that is, electricity from non-renewable sources).

The introduction of the target initiated Australia's energy transformation by providing the certainty that has enabled wind and solar to progress from one of the most expensive kinds of power generation to the cheapest. In the process, the RET has reduced the emissions from Australia's electricity sector more than any other policy, delivered tens of billions of dollars in investment.

In September 2019, the Clean Energy Regulator announced that the RET was officially met. The completion of the RET more than a year ahead of schedule was a remarkable achievement. Now that the RET has been fulfilled, questions have inevitably begun to turn to what's next. The continued absence of an approved national policy to replace the RET leaves clean energy, and the energy industry as a whole, in a state of uncertainty at a time when investment in new generation should be increasing to replace the ageing fleet of coal-fired power stations and meet Australian emissions reductions commitments.

6.2 SOLAR

6.2.1 Large-scale outlook

Industry firms supply electricity to the wholesale market using large-scale photovoltaic generation systems, or solar thermal systems (note: PV systems with a generation capacity of less than 5 MW are excluded from the industry).
Industry revenue was estimated to grow at an annualised 102.8% over the five years through 2020, to total $298.3 million. This growth has been driven by the development of a multitude of large-scale solar farms, which have increased industry generation capacity from less than 50 MW in 2014 to over 3,600 MW in 2019. Industry generation capacity is expected to continue growing in the current year, as an increasing number of solar projects come online. Industry revenue is projected to increase by 18.2% in 2020. The slower growth in the current year is attributable to the expected decline in wholesale electricity prices.

The industry's rapid growth over the past five years is partly attributable to a high level of industry assistance. Various State and federal policies, particularly the Renewable Energy Target, have helped private firms to overcome significant barriers to entry. Cheap debt funding from the Australian Renewable Energy Agency and Clean Energy Finance Corporation has helped firms meet high upfront development costs. The market for large-scale generation certificates (LGCs), as part of the RET, has also provided a major source of revenue for industry firms. Overall, industry assistance has created the potential for high profit margins for players, which has attracted a large number of new entrants.

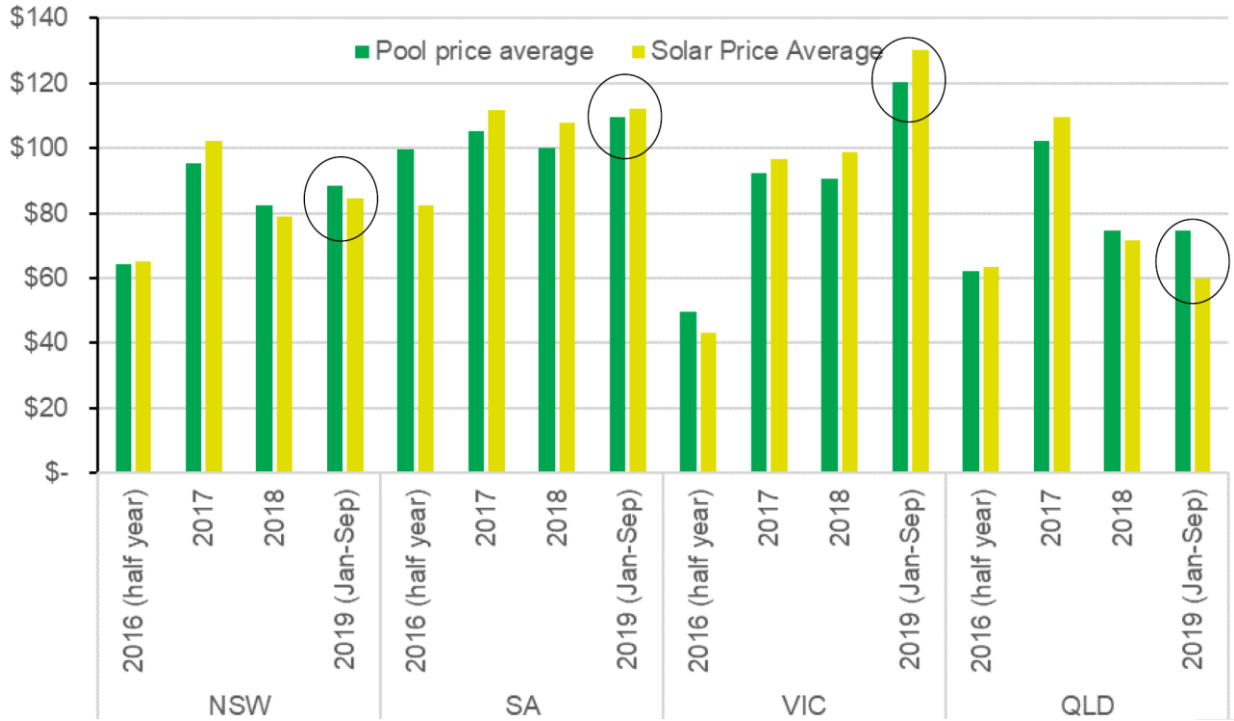
Key Statistics Snapshot	Total Revenue 2020	Annual Growth 2015-2020	Annual Growth 2020-2025
	$298.3m	**102.8%**	**14.1%**

The industry is forecast to continue growing strongly: revenue is anticipated to increase at an annualised 14.1% over the five years through 2024-25, to total $576.1 million. Growth in industry generation capacity is projected to be partly counteracted by lower prices for electricity and LGCs.

New industry projects are likely to focus on developing large-scale energy storage infrastructure in conjunction with solar farms.

Electricity wholesale prices are forecast to continue declining from their 2018-19 peak over the next five years. Several renewable energy projects are likely to come online over the period, with this expansion in capacity anticipated to increase Australia's electricity supply, and exert downward pressure on prices. As renewable capacity increases, the price of LCGs is projected to continue declining. Additionally, the Federal Government's Renewable Energy Target of sourcing 33,000 GWh of Australia's electricity usage from renewable sources, was met in late 2019. As demand for LCGs remains flat, and renewable electricity supply continues to grow, the price of LGCs is anticipated to gradually decline.

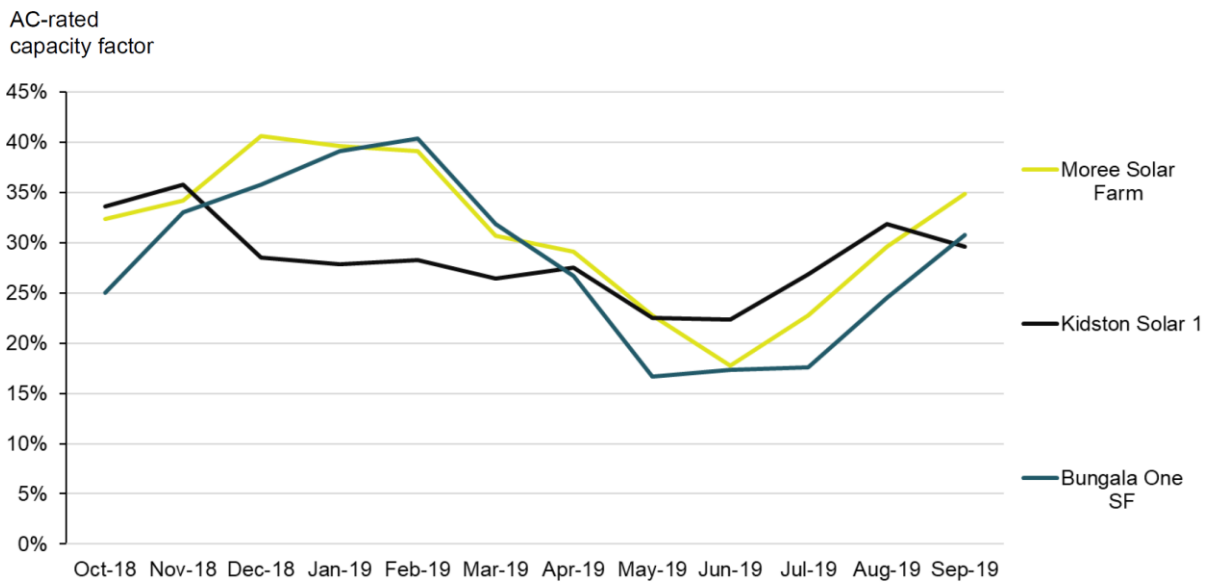
The price for Solar energy could vary from State to State, as indicated in the following diagram.



Source: Green Energy Markets (All-Energy Australia, October 2019)

Australia's ageing fleet of coal fired power stations is projected to deteriorate over the period (Chapter 5.1.2), boosting the attractiveness of solar farms to policy makers and investors. Major electricity retailers are forecast to replace coal fired power stations with renewable projects, to increase reliability and reduce costs over the period. For example, AGL Energy is forecast to decommission the Liddell power station by 2023. This facility is anticipated to be replaced by a combination of wind, solar and battery infrastructure. Over the next five years, renewable sources of energy are projected to account for an increasingly large share of national energy production.

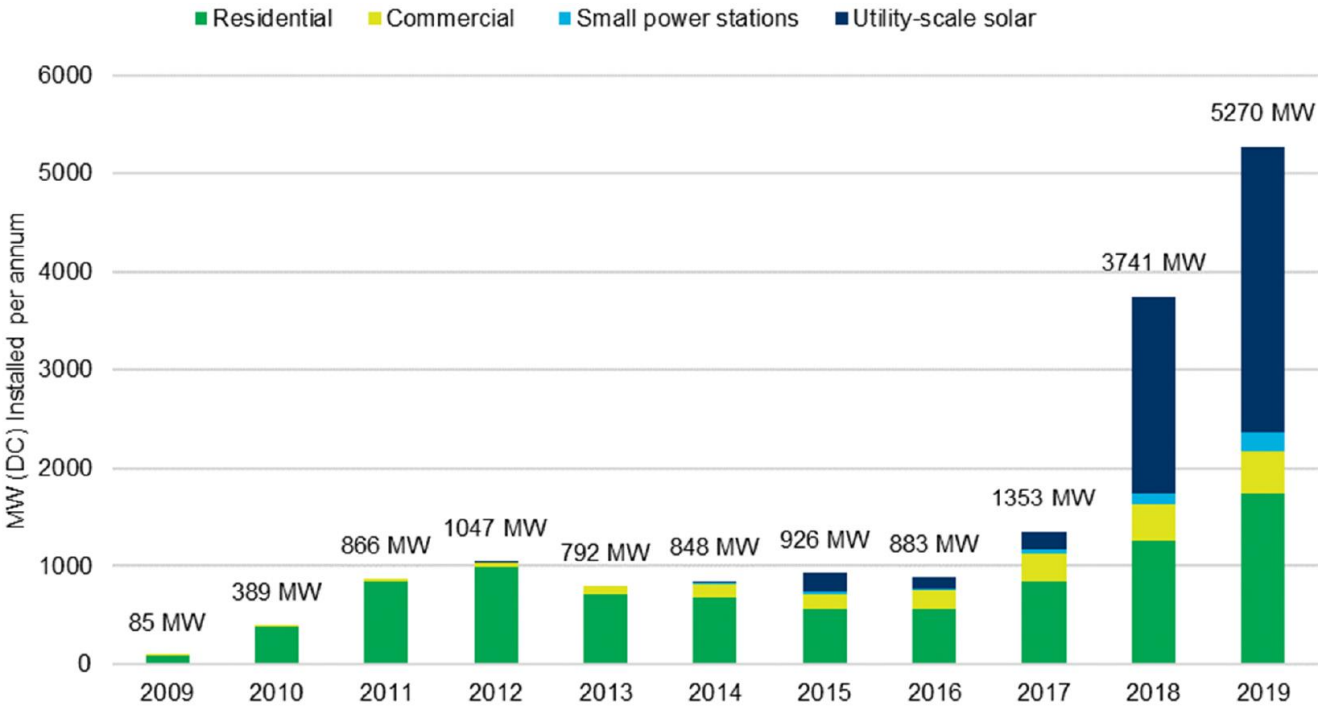
As a result of the forecast increase in participation, the industry's level of market share concentration is projected to decline. New operators are anticipated to sign electricity off-take agreements with downstream retailers to secure funding for construction. New transmission lines are likely to be developed to connect solar farms to the national grid.



Examples of performing Large-scale Solar Farms

6.2.2 Small-scale outlook

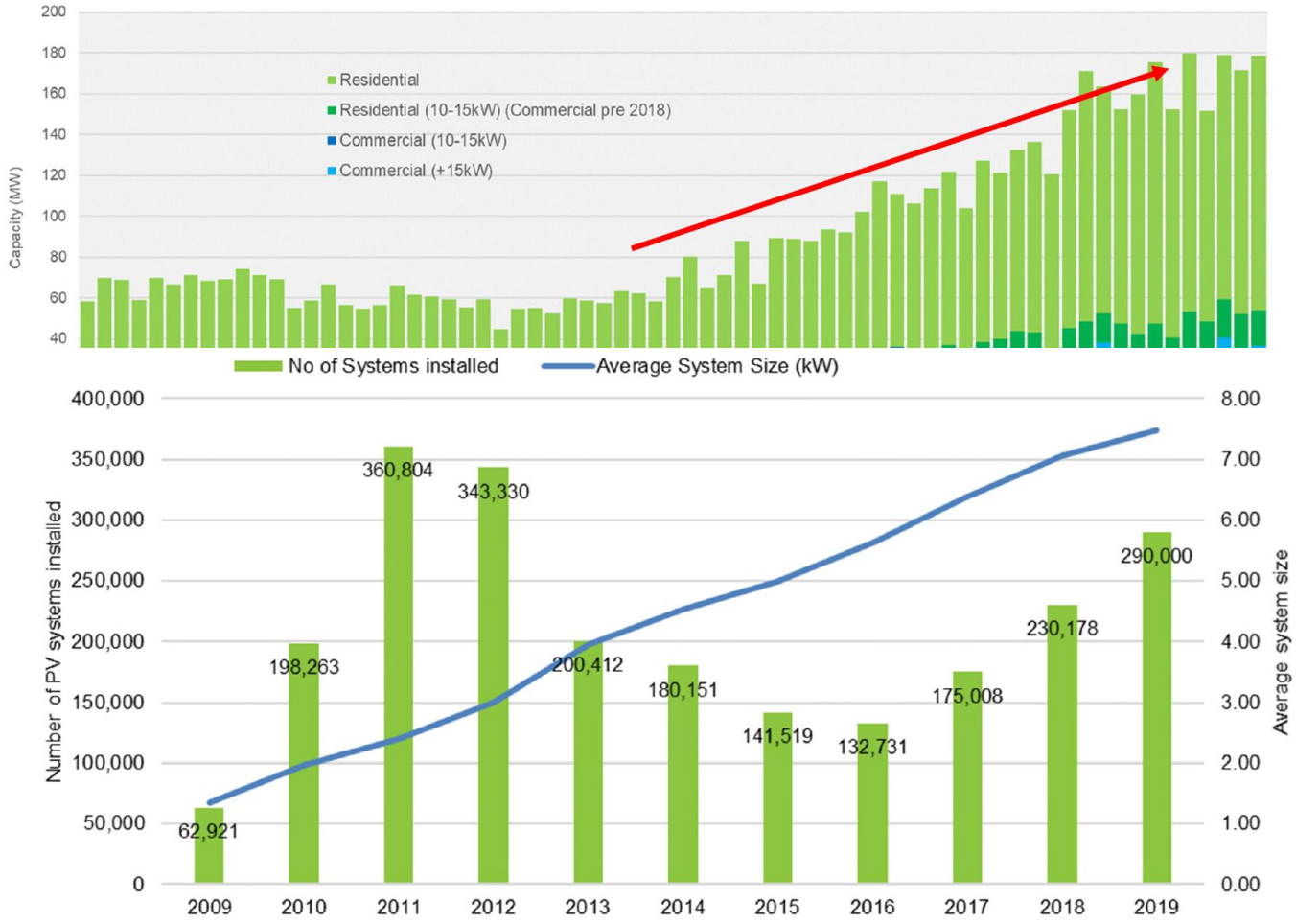
2019 was another record year for Solar PV in Australia and the market is on track to have more than 2,400 MW of rooftop Solar PV installed (excluding utility scale projects). Commercial installations are expected to account for 640 MW or 20% of the total.



Source: Green Energy Trading (All-Energy Australia, October 2019)

Note: Residential – systems installed up to 15 kW, Commercial – systems installed between 15 kW and 100 kW, Small power stations – systems above 100 kW (to be registered as power stations under the Renewable Energy Target), Utility-scale – systems installed greater than 5 MW

As per the following diagrams, small-scale PV is continuing to surge: the PV market had been flat or falling from 2014 to 2016, but it indicated an increase in activity since Q4 2016. Amongst the possible reasons are the rise of wholesale power prices, the reduced deeming each year, the fall of installation cost and the increasing size of the residential systems.



Source: Green Energy Trading (All-Energy Australia, October 2019)

Over the past five years, all State and Territory governments have provided feed-in tariffs for households, encouraging the uptake of solar panels. However, reductions in subsidies and feed-in tariffs have reduced the economic value of solar panels, leading to a slower rate of annual installations.

Industry revenue has fluctuated significantly over the past five years, as households have rushed to install systems ahead of changes to subsidies. This trend has resulted in peaks and troughs in industry activity. Solar Panel Installation Industry revenue is expected to rise at an annualised 3.4% over the five years through 2020, to $1.8 billion. Industry revenue fell in 2013-14 and 2015-16 due to reductions in subsidies and declines in the price of solar panels. Industry revenue is set to fall by 4.1% in 2020, as solar panel prices decline. Demand for solar installations from households is also expected to decrease in the current year, in response to falling electricity prices.

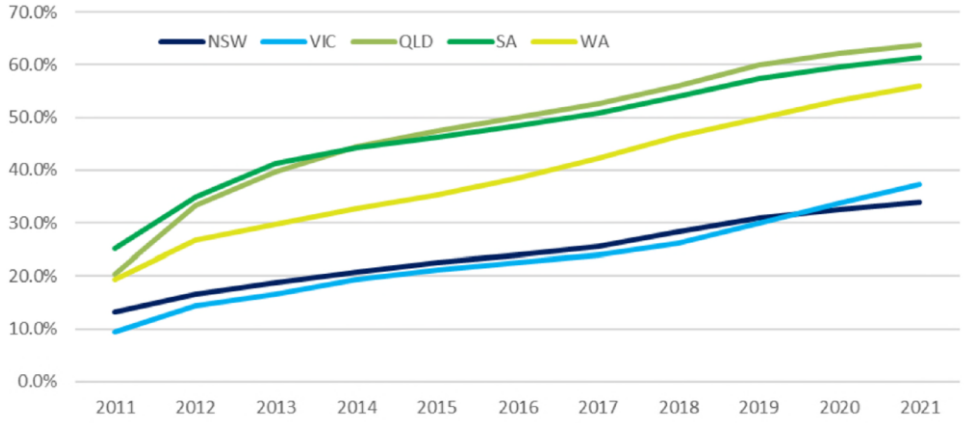
Key Statistics Snapshot	Total Revenue 2020	Annual Growth 2015-2020	Annual Growth 2020-2025
	$1.8bn	**3.4%**	**-1.2%**

Industry revenue is projected to decline over the next five years, due to government subsidy withdrawal, ongoing declines in the overall cost of solar systems and decreases in the cost of substitute energy available to households. Consequently, industry revenue is forecast to fall at an annualised 1.2% over the five years through 2024-25, to $1.7 billion. The industry's revenue volatility is anticipated to decline over the next five years, as households begin to adopt solar panels based on cost benefit rather than government subsidies.

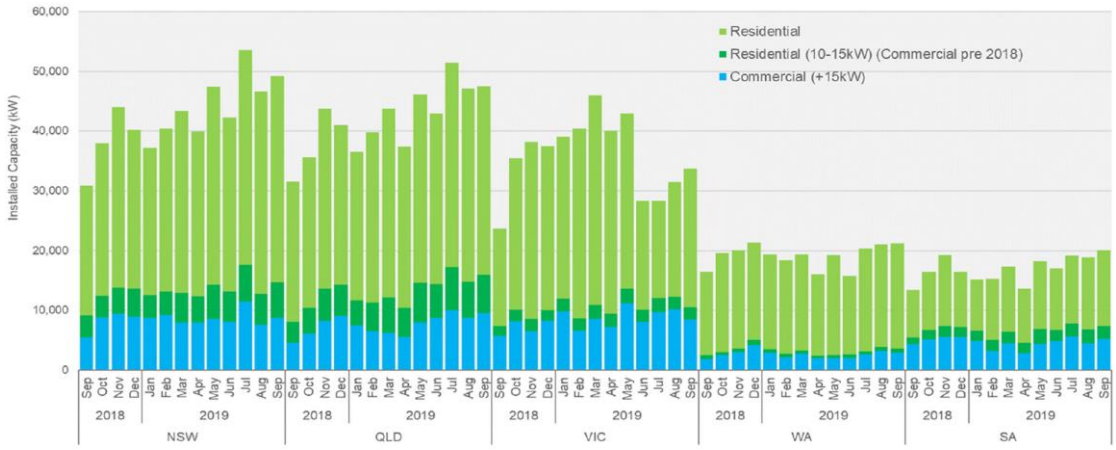
Product segmentation:

- Systems up to 9,5 kW 51,4%
- Systems from 9,5 kW to 25 kW 23%
- Systems from 25 kW to 100 kW 25,6%

The Solar penetration rate, representing the cumulative proportion of residential systems installed as a proportion of owner occupied houses, is steadily increasing.



With regard to other source of energy, there are differences in the way States have embraced the trend, with New South Wales and Queensland leading Australia in the installation of new small-scale solar systems (Victoria has declined due to solar program cap). However, there is an expectation of a reduction of installations, as the market is reaching saturation and the value of exported electricity is reducing.



Competitive landscape

The Solar Electricity Generation industry displays a moderate level of market share concentration, as the four largest operators are expected to account for 58.4% of industry revenue. As the industry is still in its growth phase, its market share concentration has been dominated by the few operators that have been able to complete their projects before other players. As additional capacity been brought online by industry entrants, market share concentration has significantly declined.

With regard to solar panel installation, industry operators tend to be small businesses that operate in single geographic areas. Some of them install solar panels on behalf of the major energy retailers (i.e. Origin Energy, AGL and EnergyAustralia).
The Clean Energy Council approves solar retailers and installers, and maintains a database of approved businesses. Although most industry firms operate in specific geographic regions, a small number of national operators exists. National operators include Bradford Energy, Solarhub, Epho Pty Ltd, Photon Energy, and several others. No firms are expected to account for more than 2% of industry revenue in 2020.

[For the list of the major Solar Energy players, please contact FIT Melbourne]

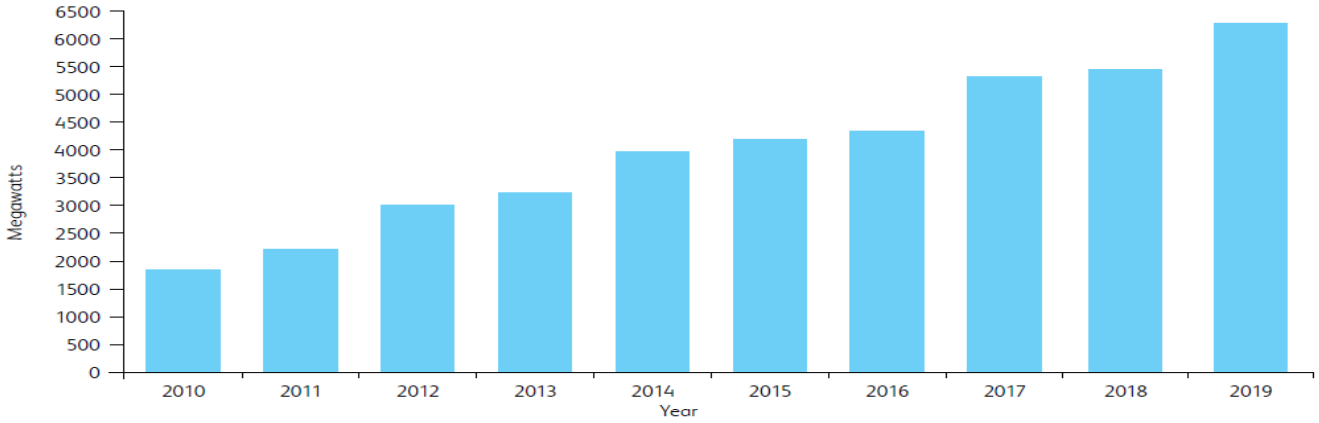
6.3 WIND (ONSHORE)

High wholesale electricity prices, favourable industry assistance programs and increasing profitability have attracted new firms to the industry, with revenue expected to increase at an annualised 3.1% over the five years through 2020, to reach $1.2 billion. This includes an estimated decline of 23.7% in the current year, due to a strong drop in the South Australian wholesale price of electricity.

As investments in wind farms have grown over the past five years, at December 2019, there was 6,279 MW of installed wind power capacity and a further 21,845 MW of capacity was proposed or committed to the electricity sector in Australia as of February 2020. At the end of 2019 there were 101 wind farms in Australia, most of which had turbines from 1.5 MW to 3 MW. In addition, 30 projects with a combined installed capacity of more than 5,500 MW are either under construction or committed to be built in 2020-2021 having reached financial closure.

For the first time, wind overtook hydro as Australia's leading source of clean energy in 2019, supplying 35.4% of the country's clean energy and 9.5% of Australia's overall electricity. In 2019 over 837 MW of wind energy was installed, making it the best ever year for the sector.

CUMULATIVE INSTALLED WIND CAPACITY IN AUSTRALIA[97]



YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CUMULATIVE INSTALLED CAPACITY (MW)	1840.1	2240.9	3009.2	3233.8	3961.5	4181.0	4324.10	4811.7	5442.3	6279.4

The industry has benefited from the Renewable Energy Target scheme, which has provided a secondary source of revenue through the market for large-scale generation certificates (LGC). The price of LGCs has increased significantly, as RET obligations have forced electricity retailers to source 18.6% of their total electricity sales from renewable sources in 2019.

Key Statistics Snapshot	Total Revenue 2020	Annual Growth 2015-2020	Annual Growth 2020-2025
	$1.2bn	**3.1%**	**3.1%**

Industry revenue is anticipated to continue rising over the next five years, as growth in production capacity is counteracted by declining wholesale electricity and LGC prices. Strong demand for sustainably produced energy, and relatively high profitability, is expected to encourage growth in industry participation over the period. Overall, industry revenue is expected to increase at an annualised 3.1% over the five years through 2024-25, to reach $1.4 billion.

As Australia has abundant wind resources, which can be reliably used in conjunction with dispatchable power sources (i.e. pumped hydro or batteries), investment to harness these resources is projected to continue rising over the next five years.

Major markets segmentation:

- Electricity retailers 27,2%
- Commercial and services sectors 18,6%
- Household 16,8%
- Manufacturers 16,3%
- Mining firms 10,2%
- Utility providers 9%
- Other sectors 1,9%

Competitive landscape

The industry exhibits a moderate level of market share concentration, with the five largest operators expected to account for approximately 60% of total revenue in the current year. Due to current regulation and policy, which provide significant assistance to industry firms, many players active in other areas of the electricity sector have been investing in renewable generation. This trend has resulted in more operators entering the industry through small-scale projects and joint ventures over the past five years.

With regard to Wind Farm Construction, the industry exhibits a moderate level of market share concentration, which has increased substantially in recent years due to the tendency for the largest players to construct the large-scale wind farms. During 2019-20, the four largest players in the industry are expected to contribute about 63.6% of industry revenue. The number of total industry competitors is limited, totalling approximately 40 enterprises in 2019-20.

[For the list of the major Wind Energy players and Wind Farm Construction companies, please contact FIT Melbourne]

6.4 HYDRO

The industry's performance is largely tied to trends in wholesale electricity prices, particularly in New South Wales and Tasmania, where most large-scale assets are located (State-owned operators Snowy Hydro Limited and Hydro Tasmania). Most industry activity occurs within the National Electricity Market, which covers Eastern and Southern Australia.

Industry revenue is expected to grow at an annualised 21.2% over the five years through 2019-2020, to total $1.3 billion. The industry has been highly volatile over the past five years, driven by significant fluctuations in wholesale electricity prices. In addition, several revisions to environmental and energy policies have further contributed to volatility.

The Basslink Interconnector, which connects Tasmania to Victoria and consequently the NEM, was shut down for over six months during 2015-16. This coincided with weak rainfall at Hydro Tasmania's power plants during the year, leading to a shortfall in electricity supply in Tasmania. As a result, wholesale prices almost tripled in Tasmania and industry revenue skyrocketed by 166.6% in 2015-16. Over the three years through 2019-20, revenue grew as wholesale electricity prices across the NEM reached record levels.

In 2020, revenue is expected to fall by 13.2% as wholesale electricity prices decrease, and so industry revenue is projected to decline at an annualised 0.9% over the five years through 2024-25, to $1.2 billion.

Key Statistics Snapshot	Total Revenue 2020	Annual Growth 2015-2020	Annual Growth 2020-2025
	$1.3bn	**21.2%**	**-0.9%**

Structural changes affecting energy production in Australia are anticipated to influence the Hydro-Electricity Generation industry over the next five years. The Federal Government's plan to expand the Snowy River Scheme (known as Snowy 2.0) will mark the first significant large-scale expansion in the industry for decades.

A feasibility study was undertaken to determine whether the expansion, which would use pumped-storage technology, is economically viable. The project received a final investment decision in December 2018, and is expected to be completed in 2025.

Changes in regulatory policy are also likely, particularly as the Renewable Energy Target expires in 2020. Wholesale electricity prices are forecast to decline over the five years through 2024-25, but from a high base.

Competitive landscape

The limited number of economically viable sites for development of large-scale hydro-electric plants is the primary reason for the industry's high concentration. The industry's four largest players (including CleanCo Queensland Limited, a Queensland Government-owned company operating three hydro power stations) are expected to account for over 95% of total revenue in 2019-20.

[For the list of the major Hydro Energy players, please contact FIT Melbourne]

6.5 BIOENERGY

Bioenergy is one of world's primary sources of renewable energy, with a long track record of cost-effectively reducing carbon emissions, improving energy productivity and generating reliable baseload renewable energy. But these technologies are not widely deployed in Australia, contributing only 0.9% of Australia's electricity output in 2019.

According to a market study prepared by KPMG on behalf of Bioenergy Australia in 2018, there were 222 operating bioenergy plants and additional 55 projects were either under construction or within the feasibility stage of development. Collected data showed that out of the 222 operating projects, 165 produced electricity: 40 generated over 5 MW and 62 generated between 1 MW to 5 MW. There were 14 projects that produced bioproducts (fuel, wood pellets for export, chemicals etc.) and 43 producing 'other', which include flaring projects and biogas to support behind the meter operations (mostly flaring methane from municipal waste sites).

The pictures below indicate the operating bioenergy projects by State / Territory and feedstock, and the segmentation by technology, feedstock and end-use, as at September 2018.

WA (22)
Municipal waste: 68%
Agricultural residue: 18%
Wood waste: 14%

NT (1)
Municipal waste: 100%

QLD (49)
Municipal waste: 57%
Agricultural residues: 27%
Animal residues: 10%
Wood waste: 6%

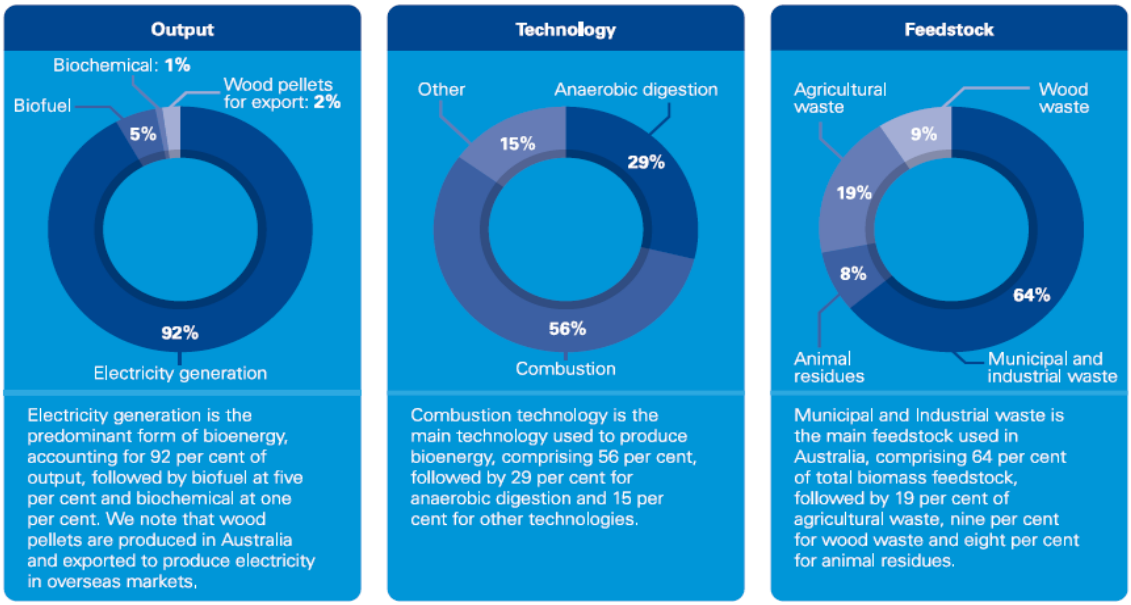
NSW (53)
Municipal waste: 58%
Agricultural residue: 23%
Animal residues: 17%
Wood waste: 2%

ACT (3)
Municipal waste: 100%

VIC (35)
Municipal waste: 71%
Wood waste: 17%
Agricultural residue: 9%
Animal residues: 3%

TAS (6)
Municipal waste: 67%
Wood waste: 33%

SA (10)
Municipal waste: 80%
Agricultural residue: 10%
Wood waste: 10%



Source: Bioenergy State of the Nation Report 2018, KPMG

The Federal Government's commitment to the future of Australia's bioeconomy has been proven by the developing of a roadmap for Australia's bioenergy future. Therefore at the request of the Government, the Australian Renewable Energy Agency has started to develop the roadmap to help prepare the next series of investment and policy decisions in the bioenergy sector) and has called for public submissions on how Australia can build its bioenergy sector and strengthen the country's energy security.
Over the past 8 years, ARENA has provided approximately $118 million in funding towards bioenergy projects, including electricity and biogas production, biofuels, efficient feedstock harvesting technology and projects that aim to capture energy from a range of waste materials.

In May 2020, leading energy infrastructure company, Jemena, called for a national approach to green accreditation for renewable gases, such as biomethane and hydrogen, as part of its submission to the Australian Renewable Energy Agency Bioenergy Roadmap. A certification system would enable customers to purchase verified and accredited zero emission gas as is currently the case for renewable electricity.

According to Jemena, several green hydrogen gas trials have commenced for domestic and international markets across the nation, including the Western Sydney Green Gas project, in which the first electrolyser in New South Wales will be installed later this year: this technology utilises solar and wind power to create carbon neutral hydrogen gas, which is stored in the Jemena Gas Network, making it accessible to homes, business and the vehicle industry.

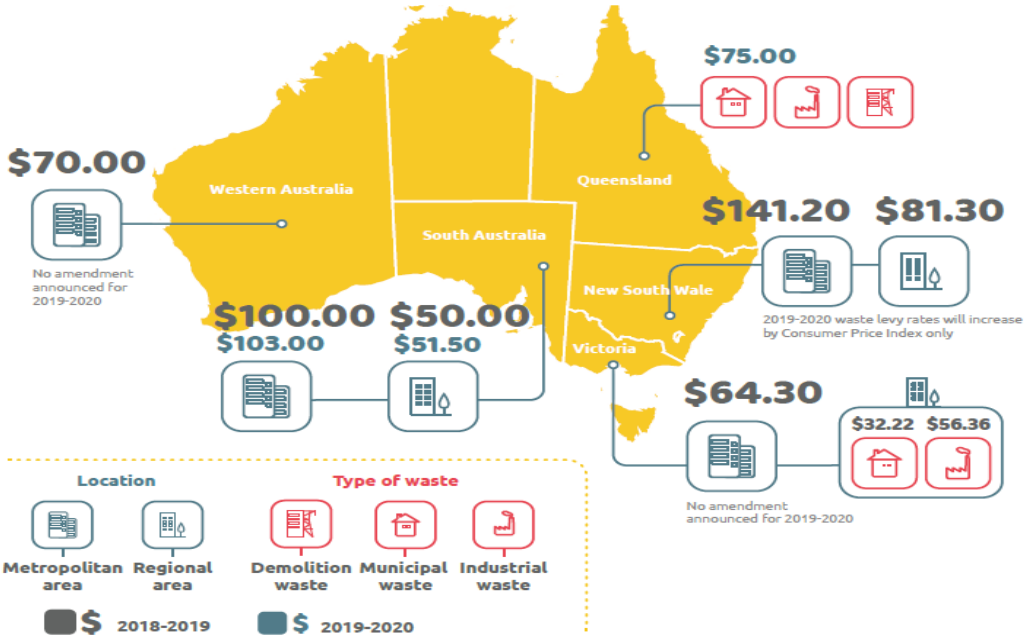
The major challenges the industry has to face in order to further grow are mostly related to industry policies, and they could be listed as follow:

- Absence of specific national targets for biogas production (Clean Energy Council suggested targets for electricity generation from bioenergy in general, 2,413 GWh by 2020 and 55,815 GWh by 2050);
- Absence of a regulatory framework and a national target for biomethane production;
- Financial uncertainties associated with power exported to the grid;
- Gaseous fuel tax, as Compressed Natural Gas and Liquified Natural Gas are taxed by the Australian Taxation Office, regardless if they are from renewable or fossil sources;

- Digestate regulations, as there is a lack of consistent national regulation for the digestate, which can be classified as a waste, a biosolid or a compost depending on the States and on the level of treatment done on the digestate;
- Landfill waste levies.

6.5.1 Landfill waste levies

In Australia landfilling comes at a cost that has been valued at approximately $120/tonne of waste after taking into account post-closure remediation and replacement costs. Landfill sites also incur environmental and social costs of GHG emissions and odour release. As a consequence, several States have put in place waste levies to recover landfill costs: for the States where waste levies are available, they act as an imperative economic driver providing an additional source of income and enhancing the viability of biogas projects. (as outlined in the figure below). The development of the biogas sector could benefit from more uniform levies between the States.



Source: ENEA Consulting and Bioenergy Australia, "Biogas opportunities"

6.6 BLUE ENERGY

Australia has some of the best wave energy resources in the world and it's estimated that wave power has the potential to play a large part in Australia's future energy mix by 2050. However, to reach that point, three key knowledge gaps must be addressed: a] limited knowledge of the resource, including its temporal and spatial variability and its spectral characteristics; b] difficulty accessing spatial information identifying multiple designated marine management regimes of Australian marine territories; c] limited evidence-base and methodology for assessing impacts of wave energy extraction on the marine and coastal environment in Australia.

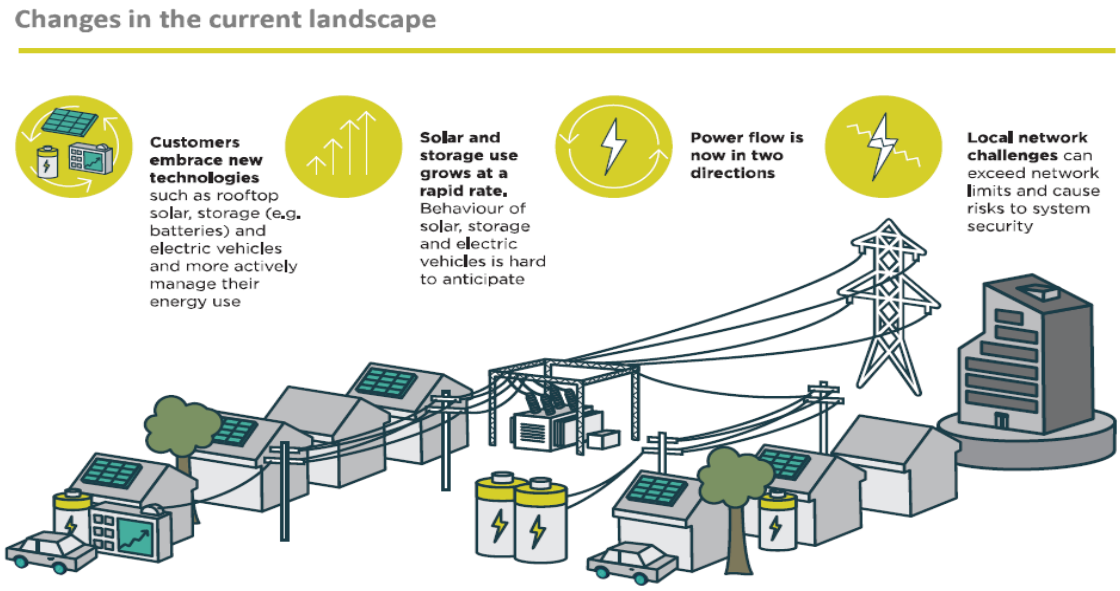
Australia has a number of innovative technologies in both wave and tidal energy, but the main challenges are capital cost / project financing and environmental impact / withstanding damage from harsh ocean conditions. The Australian Renewable Energy Agency has provided funding support for 14 ocean projects, working with the ocean energy industry, sharing lessons from Australian wave energy projects and supporting activity to advance the sector through R&D and demonstration projects. This enables potential investors to identify sites for further investigation, and policymakers to have better information regarding the potential for ocean energy to contribute to Australia's energy mix.

[Please contact FIT Melbourne for the list of the major companies operating in the Blue Energy sector]

6.7 PROSUMERS AND DISTRIBUTED ENERGY RESOURCES

6.7.1 "Prosumers"

What were once networks of poles and wires operating one way electricity supply to a customer are evolving into a two-way system, where consumers can export power to the grid via their own mini generation systems (i.e. rooftop solar and, increasingly, batteries). There has been enormous growth in household solar: in 2008, there were just 14,000 solar PV systems installed on Australian rooftops, while today there are more than 2 million (Chapter 6.2.2). This change poses significant opportunities, but also challenges for networks to manage the safe and reliable integration of all these Distributed Energy Resources into the grid.



The new figure of the "prosumer" is defined as "someone who both consumes and produces electricity and/or provides services to the grid".
As smart meters are rolling out across Australia, consumers have access to data to make better decisions to generate and sell their own power and actively monitor / manage energy use. Of course, there are rural and regional areas with poor mobile coverage, there are other areas where offering smart meters would be "uneconomic" and some consumers might present lack of financial and digital literacy.

6.7.2 Distributed energy resources

Distributed Energy Resources is the name given to renewable energy units or systems that are commonly located at houses or businesses to provide them with power. Another name for DER is "behind the meter" because the electricity is generated or managed 'behind' the electricity meter in the home or business. Common examples of DER include rooftop solar PV units, battery storage, thermal energy storage, electric vehicles and chargers, smart meters, and home energy management technologies.

Distributed Energy Resources are changing the way Australia produces and manages electricity: rather than electricity being generated by large, centralised power stations, it is now starting to come from many places including millions of homes and businesses.

The demand for DER in Australia is also expected to grow, with the Electricity Network Transformation Roadmap estimating that by 2050 DER may contribute up to 45% of Australia's electricity generation capacity.

This means that the organisations responsible for managing the electricity system have a massive challenge to ensure that it all works together and the electricity grid remains stable.

In 2018, ARENA established the Distributed Energy Integration Program (DEIP), a collaboration of Government agencies, market authorities, industry and consumer associations with the shared aim of maximising the value of customers' DER for all energy users. The DEIP supports information exchange and collaboration on DER issues, enabling a more efficient identification of knowledge gaps and priorities, and accelerating reforms in the interest of customers. ARENA is also providing funding support for projects that demonstrate how the effective use of distributed energy resources can help Australia transition to a secure and reliable grid with a high share of renewables.

In 2019, ARENA awarded $9.6m in funding for 12 DER research and demonstration projects to develop new ways to understand and manage the effect of high levels of DER in different parts of the electricity grid. The projects examine how grids can connect more DER cheaper and faster while reducing costs and operations within the technical limits of the power system. This investment is helping networks, retailers, Government and system operators understand and overcome the technical and commercial challenges of managing a grid with a large share of DER.

6.7.3 Virtual Power Plant

If properly managed, solar and storage systems can work together as Virtual Power Plants, reducing the need for investment in poles and wires infrastructure, which will ultimately save customers money on power bills. In Australia, VPPs are typically focused on coordinating Distributed Energy Resources (rooftop photovoltaic systems, battery storage and controllable load devices, such as air-conditioners or pool pumps), through the market, to deliver the types of services that would traditionally be performed by centralised thermal power plants.

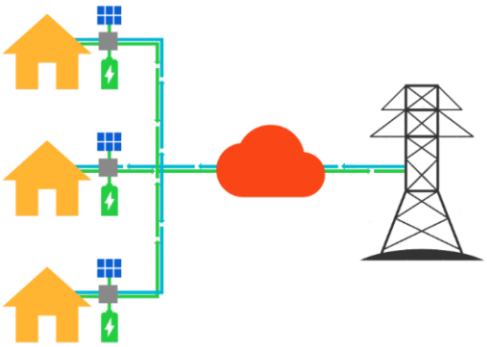
The Virtual Power Plant demonstration in Australia shows financial and network value of home batteries. For example, home batteries in South Australia have been delivering significant revenues from their first six months of participation in a virtual power plant to help balance the grid, even with only an initial 1 MW – 2 MW of aggregated customer systems participating.

The Australian Energy Market Operator, which covers large portions of the South Eastern and Western parts of the country, released an initial report on its VPP Demonstration Programme, based on data collected from July 2019 onwards. With the first rollout of the VPP trial in the state of South Australia, the services provided an initial 1 MW of systems expanded to 2 MW in November 2019.
The applications served mainly covered frequency regulation and also dealt with imbalances caused in the energy market that include negative pricing, which can occur when the system has an oversupply of resources. While VPPs have been in use for many years, the enabling of home batteries, which can act bi-directionally and feed in energy to the grid as well as take energy out, is the key to this new configuration from a network point of view.

AEMO established the demonstrations to integrate DER into the NEM

Trials with existing pilot scale VPPs began in June/July 2019 and run for at least 12 months

Integration will maximise the value to consumers while also supporting power system security.

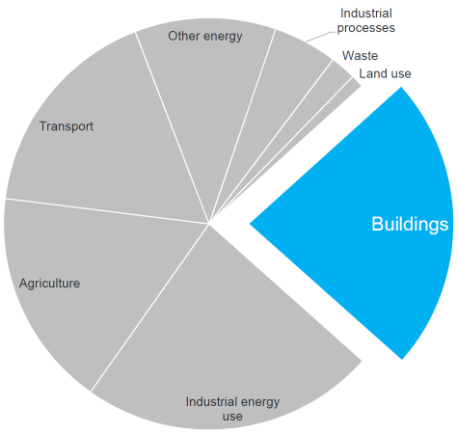


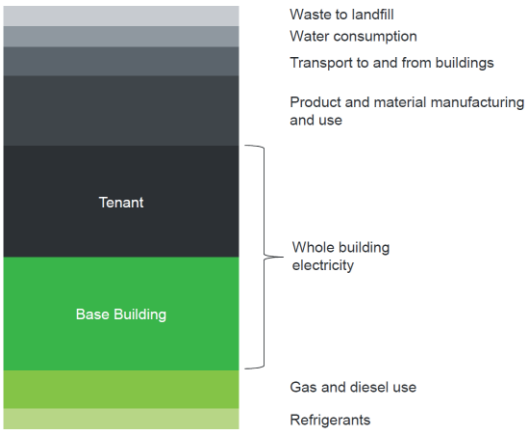
Source: Origin Energy

The VPP operators are also responsible for deciding how revenues generated are shared with customers. For example, Tesla Powerwall systems were offered to customers via retail partner Energy Locals, with consumers receiving discounts on their purchases in return for some of the batteries' capacity being made available for those network-balancing services. According to Energy Locals' website, this means that with Government rebates being offered, customers can save as much as 35% from the list price.

6.7.4 Renewable Energy in the building industry

Buildings represent 23% of all emissions in Australia and they account also for more than half of Australia's electricity consumption and are a major driver of peak demand for electricity. On-site renewable energy generation coupled with energy efficiency, smart building controls and energy storage can help reduce the load buildings place on the electricity grid, improve grid management and help reduce energy costs for households and businesses.





Source: Green Building Council of Australia

Renewable energy and related technologies relevant to the Australian built environment include: building integrated PV systems, hot water systems and solar heating and cooling systems, and energy storage systems (such as batteries and thermal storage including hot water storage and storage of warmth and "coolth" in building structures).

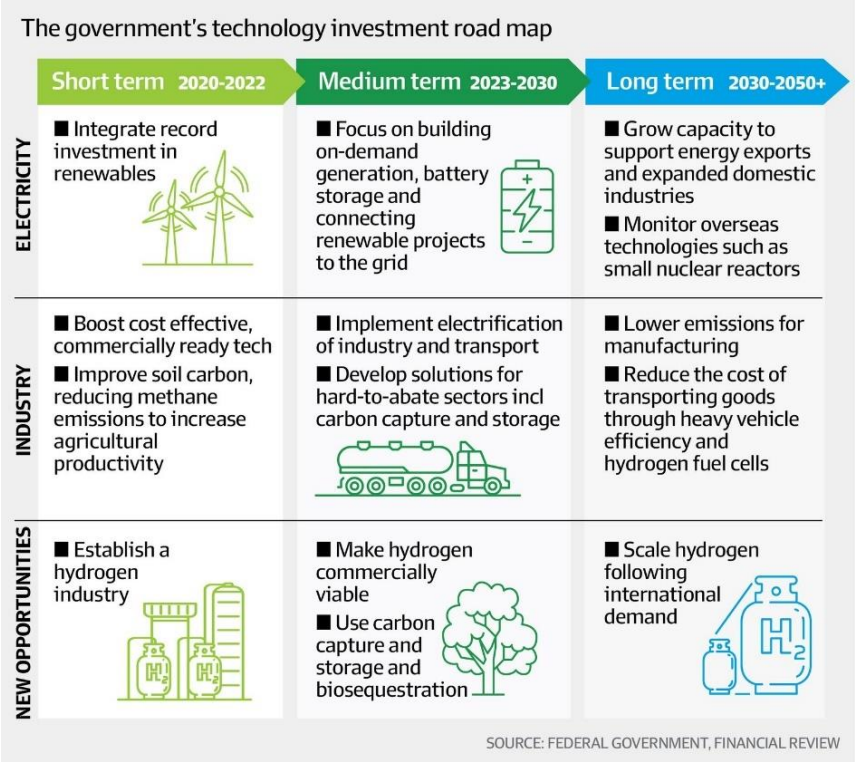
As around 160,000 new detached or semi-detached dwellings are built in Australia each year, Sustainability Victoria is running the "Zero Net Carbon Homes" pilot program: an initiative to drive the uptake of energy efficient and sustainable design features to minimise energy consumption and improve thermal comfort levels. The final goal is to reduce the demand on the grid and significantly reduce energy bills for homeowners. According to the project, residential building company Mirvac is building 49 townhouses to demonstrate the feasibility of achieving zero energy homes at scale: each of the townhouses has been designed with a minimum 7- star energy rating (indicating a very high energy efficiency), has a minimum of 3.8-5 kW rooftop solar array, 10 kWh home battery storage, real-time smart home energy monitoring, upgraded wall and roof insulation, double glazed windows and energy efficient electric appliances, heating, cooling, lighting and hot water systems.

7. ENERGY TRANSITION TO CLEAN ENERGY

7.1 FEDERAL GOVERNMENT

Australia commenced its energy transition in the early 2000s with legislation of a national Mandatory Renewable Energy Target (MRET Review Panel, 2003). This target, while small (only 2%), was rapidly achieved and later expanded to a 20% target by 2020 and late 2019 the Clean Energy Regulator announced that enough capacity has been approved for the target to be met.

In May 2020 the Federal Energy Minister released the discussion papers for the long-awaited energy technology investment road map: after years of policy paralysis on energy and climate, with everything seen through the "coal vs renewables" paradigm, the road map tries to clear up once and for all that renewable energy will provide the backbone of Australia's power system in the second half of the century.



Coal, which is now responsible for 56% of Australia's electricity generation, is only mentioned 20 times in the 93-page discussion paper and almost in passing. Anyway, it's too early to tell whether the cursory reference to the importance of coal will be enough to appease the pro-coal supporters in the Coalition Government, who want the Federal Government to underwrite a new coal-fired power station in North Queensland or extend the life of AGL Energy's Liddell power station in NSW. Right now, coal-fired power offers stable generation, but gas would play an more important part in "balancing" renewable energy sources, providing back-up for intermittent solar and wind. Flexible gas capacity will continue to play a crucial role in supporting variable renewable energy, alongside continuing growth in energy storage, demand management and innovative grid technologies as alternatives. As the world's largest LNG exporter, all of these factors will have implications for Australia's domestic gas market and export opportunities over the long term.

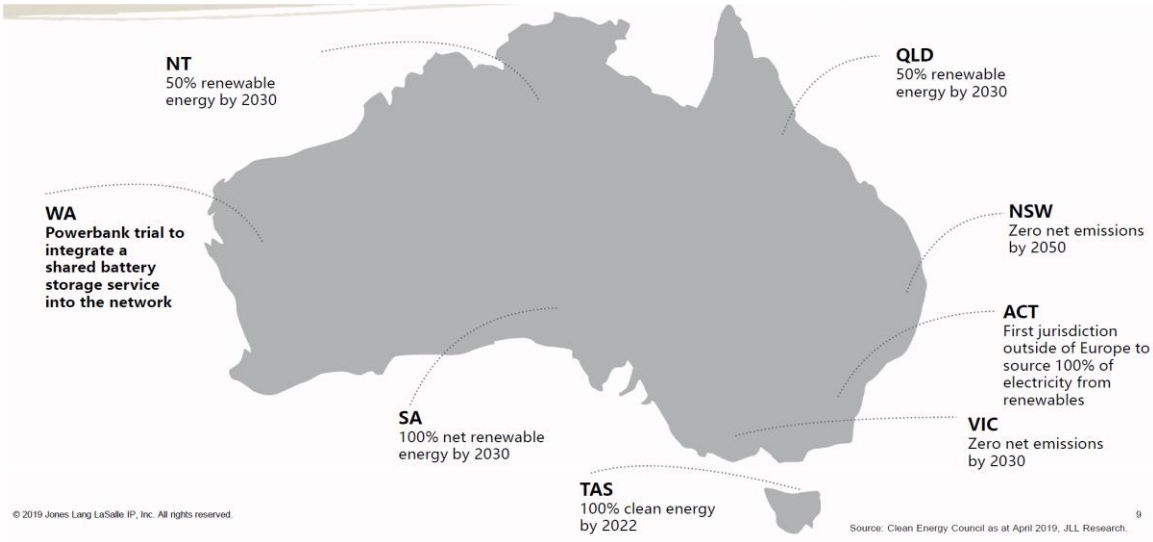
For Federal Energy Minister Angus Taylor, technology is the magical wand that will help drive Australia's energy transition. Therefore the road map outlines 140 potential technologies (including hydrogen, pumped hydro, large-scale batteries and carbon capture and storage), which will help transform Australia's economy to a low-emissions future. But sceptics worry about how much reliance can be put in emerging technologies such as hydrogen, which are yet to be commercially viable (i.e. Minister's end goal of hydrogen for under $2 a kilogram seems a long way off). The document also says that over the long term there should be investment in building new "export-facing" industries such as carbon capture and storage, a controversial technology which Minister Taylor said had great potential in the industrial sector. Moreover, the paper describes emerging nuclear technologies such as small modular reactors as having "potential", but cost, environmental and social factors would determine whether they would go ahead.

For many, the discussion paper is a final concession that renewable energy is the future of the energy grid come 2050. Nevertheless, it will be existing technologies such as gas, that will help Australia reach its end goal of 26-28% reduction in carbon emissions on 2005 levels by 2030.
Several industry commentators say the road map has the potential to be the making of a long-term energy and climate policy, but a mechanism such as carbon pricing or net zero emissions target should drive the transition and an investment framework would give investors confidence to deliver these technologies on the ground. Further analysis of the roadmap in Chapter 8.

In order to reach Paris climate targets, the road map expands the focus from the energy sector to transport, agriculture and industry. The technology road map says electric vehicles, hybrids and alternative fuels would help boost road transport efficiency and reduce emissions, but they might not be ready until the next decade. In the agriculture sector, there are opportunities to improve soil carbon levels and livestock productivity as well as deploying technologies to enhance fertiliser use, carbon storage in vegetation and improve fire management.

7.2 STATE AND TERRITORY GOVERNMENTS

In 2019 the electricity generation scenario showed a diverse status according to the level of adoption of renewable energy sources from each State, as indicated in the picture below, and consequently the States and Territories announced new energy policies and launched new targets in the last years.

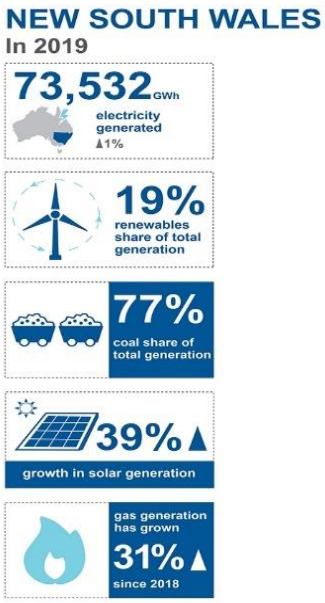


7.2.1 Australian Capital Territory (Canberra)

The ACT has delivered on its ambitious target to generate 100% of its energy needs from renewable sources. It's only the eighth major jurisdiction in the world to do this, and the first outside Europe. To maintain its 100% renewables position, the ACT launched an additional reverse auction for largescale renewable technology in late 2019. The reverse auction is open to all types of renewable energy projects, with capacities starting at 200 MW for wind and 250 MW for solar.
To move towards its target of zero net emissions by 2045, the ACT is now focusing on the two largest sources of emissions: transport (60%) and gas usage (22%). The government will commit to using renewable electricity in all new public buildings and change laws so that it's no longer compulsory for new suburbs to connect to gas.

7.2.2 New South Wales (Sydney)

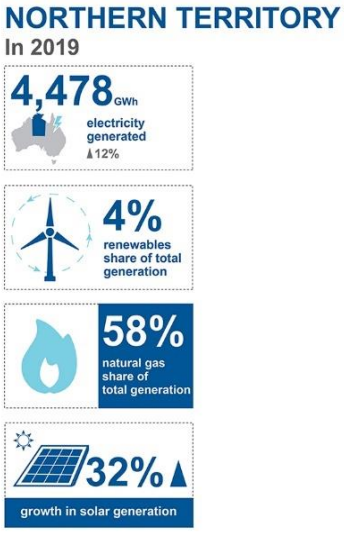
By failing to set a renewable energy target, New South Wales could fall short of its 2050 zero net emissions target. And with only 19% of the state's energy coming from renewable sources, NSW is falling well behind most other States. The NSW Government released its Electricity Strategy in late 2019, with a focus on affordable electricity and a secure energy supply. It includes a plan to create a renewable energy zone – with 3,000 MW of renewables investment – which could start to close the gap on the state's emissions target.



The NSW and Federal Governments have agreed to share the financial responsibility (up to $102 million) to upgrade the Queensland-NSW interconnector. As older power stations are decommissioned, the interconnector will have the capacity to transfer 190 MW of Queensland power to ensure a reliable energy supply for NSW and the ACT. This project is a priority under the NSW Government's Transmission Infrastructure Strategy, with plans to kick off construction in 2021 following regulatory approval.

A new 900 km interconnector between NSW and South Australia, with an additional line into Victoria, is also awaiting regulatory approval. ElectraNet and Transgrid are working together on the interconnector, called Project EnergyConnect, to deliver energy security, reduced prices and economic benefits for the states.

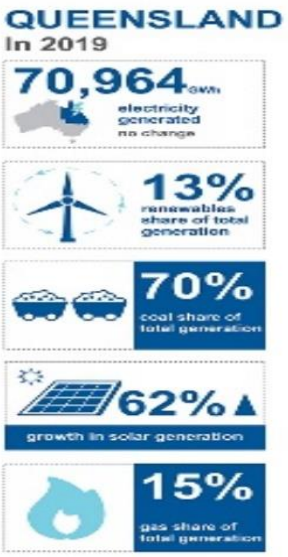
7.2.3 Northern Territory (Darwin)



The Territory remains committed to gas exports and onshore fracking, which doesn't necessarily align with its renewable energy targets. Therefore, despite a Roadmap to Renewables aiming to source 50% of its power from renewables by 2030, progress has been slow so far, with just 4% of the State's electricity sourced from renewables. But in September 2019, the NT released its response for action plan, that addresses climate risk and sets a 2050 zero net emissions target with a focus on solar. A proposal from the Water and Power Corporation seeks to impose strict conditions on new solar projects, which would make them unviable by adding as much as 30% to owner costs (the proposal would also retrospectively apply to existing projects).

Construction has begun on the NT's largest solar farm with battery storage: the 25 MW Katherine Solar Farm will include 100,000 panels and be able to generate approximately 700,000 MWh of power each year. Sun Cable's Australia/Singapore power link has been recognised with major project status due to its likely significant contribution to regional economic development: this $20 billion project includes provisions for a 10 GW solar farm and 20-30 GWh storage facility. It's the largest solar farm under development in the world. The electricity will supply the Darwin and Singapore markets with export via a 4,500 km transmission network.

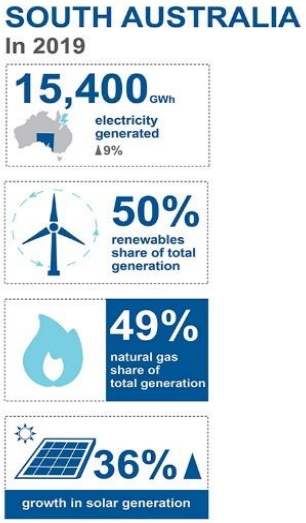
7.2.4 Queensland (Brisbane)



Queensland's newest publicly owned energy company, CleanCo, started trading on the National Electricity Market on 31 October 2019. It was a step in the right direction towards Queensland's 50% renewable energy target, but it still has a lot of work to do if it is to achieve the target by 2030. CleanCo is part of a Government mandate to support 1,000 MW of new renewable generation by 2025. Legislative change saw foundation assets owned by CS Energy and Stanwell – with the capacity to generate 1,120 MW – transferred to CleanCo. CleanCo is now responsible for the Renewables 400 procurement program, a reverse auction to build 400 MW of new renewable energy and storage projects in Queensland.

Electricity supply well above demand resulted in Queensland experiencing negative electricity prices several times towards the end of 2019. This was attributed to strong solar generation and an outage of the interconnector with New South Wales.

7.2.5 South Australia (Adelaide)

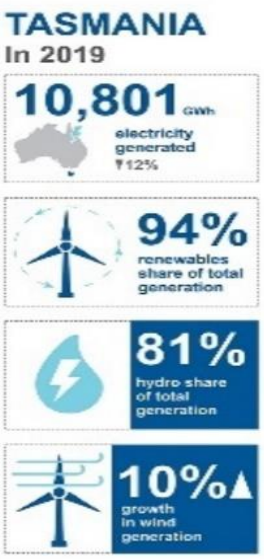


Already generating 50% of power from wind and solar, the state is now aiming to source 100% of its electricity from renewable energy by the end of the decade. Once reliant on coal, gas and imported power generation, SA now has more than 2,675 MW of large-scale wind, solar and storage.
The recent push to renewable energy led to South Australia having the lowest electricity spot prices in the country for the latter part of 2019.

The state is exploring hydrogen generation, with its wind and solar resources enabling it to generate, use and export 100% renewable hydrogen (more in Chapter 8.3.1). SA is also trialing smaller projects such as the 30 MW hydrogen electrolyser in Port Lincoln. A bigger hybrid project incorporating wind, solar and hydrogen is on the horizon at Neoen's Crystal Brook project: it will be a super hub consisting of 125 MW of wind, 150 MW of solar, 130 MW of battery storage and 50 MW of hydrogen.
In November 2019, Neoen also announced plans to expand the Hornsdale Power Reserve by 50%: the 50 MW/64.5 MWh upgrade will be able to manage 50% of SA's inertia needs and help the state towards its 100% renewable energy target (construction has already commenced on the project, with completion expected in the second half of 2020).

The new SA-NSW interconnector was given major project status by the SA Government: called Project EnergyConnect, the new interconnector will deliver benefits to South Australia, including cheaper power prices, improved reliability and opportunities to export renewable energy.

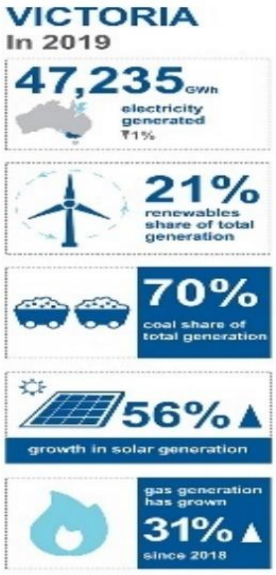
7.2.6 Tasmania (Hobart)



Tasmania's Battery of the Nation vision could see the State making a greater contribution to the National Electricity Market. Marinus Link, an additional transmission cable across the Bass Strait, is an important part of the Battery of the Nation strategy, as the cable will help to reduce power prices and improve electricity reliability. Research has found a 1,500 MW link is technically feasible and commercially viable (if it proceeds, it could be operational by 2027).

The Granville Harbour Wind Farm is now sending power to the grid, with 31 turbines completed and a 30% increase to wind power capacity: this $280 million project takes advantage of the strong winds coming off the Southern Ocean. UPC Renewables has proposed the construction of two massive onshore wind farms in Northern Tasmania that could jointly provide up to 1 GW (the two wind farms, which may also include solar, will seek development approval during 2020 with the goal of starting construction by the end of 2021).

7.2.7 Victoria (Melbourne)

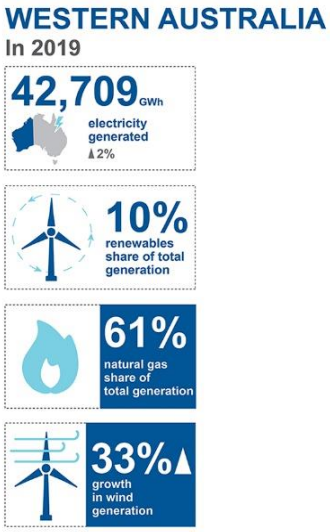


Victoria's 50% renewable energy target by 2030 became law in October 2019, amending the previous 2017 Act.

The Victorian Government has asked the Federal Government to fast-track investment in the KerangLink transmission line between NSW and Victoria: KerangLink will give Victoria greater access to energy generation from NSW, including the Snowy 2.0 pumped hydro project, which will be especially important if any of Victoria's coal-fired power plants close earlier than expected.

The Victorian Government abruptly froze rebates under its Solar Homes Program in April 2019 after a stronger than expected response to the program. This decision created significant challenges and when the program was reopened in July with a monthly rebate limit, available rebates were exhausted in less than an hour.

7.2.8 Western Australia (Perth)



Western Australia is one of only two states without a renewable energy target, but there was increasing activity in the renewable space, with several new wind and solar projects coming online or breaking ground in 2019.

APA Group opened its $40 million Badgingarra Solar Farm in December 2019: the 19.25 MW project is expected to save more than 8.5 million tonnes of greenhouse gases over the next 25 years and power 220,000 homes each year. South Energy is making a foray into the WA renewables market with proposed solar farms at Waroon ($250 million Waroon project for 183 MW that will include 488,800 solar panels and a 20 MW battery and is expected to be completed in 2022) and Benger (100 MW thanks to 265,000 solar panels and a 10 MW battery). The State's first grid-scale solar farm, Greenough River, is adding 30 MW of solar to its capacity (electricity generated by this project is sold to WA's Water Corporation for its desalination plant).

The WA Government introduced its $10 million Renewable Hydrogen Fund in 2019 (more in Chapter 8.3.1): grants of between $300,000 and $3 million will be provided for studies, setting up demonstrations or for new capital works projects; regional areas have $7 million earmarked for projects, while $1 million has been allocated for research into administration and regulatory reforms. It won't just be generating hydrogen for export, with the WA Government prioritising projects using hydrogen in regional areas, mixing it with mains gas supplies and using it for transport fuel.

The proposed Asian Renewable Energy Hub has again grown in scope to 15 GW of wind and solar capacity: the project is positioning itself for the renewable hydrogen export market with potential to generate 50 TWh per year.

8. STRATEGIC PRIORITIES | EMERGING TECHNOLOGIES

The recently released discussion papers related to the national Energy Technology Investment Roadmap (Chapter 7.1) has the objective to drive investment in low emissions technologies to strengthen the economy and support jobs and businesses. This is a key priority on the road to recovery from COVID-19 and represents the next step in the government's "technology not taxes" approach to reducing emissions. The roadmap focuses on:

- Developing technologies that will support jobs growth;
- Backing new industries that will help regional communities and local economies to prosper;
- Putting Australia at the forefront of research and development;
- Maintaining Australian track record of reducing global emissions.

The roadmap provides a framework for setting economic stretch goals for priority technology (for example, bringing the cost of green hydrogen production under $2 a kilogram) to accelerate the competitiveness of priority technologies with higher emissions alternatives. Each priority technology will have its own goal, to be developed in partnership with industry and stakeholders.
According to Australia's climate action agenda, there is enormous potential in technologies like hydrogen, carbon capture and storage, soil carbon sequestration, biofuels, resources and energy exports to reduce emissions while strengthening the economy.

8.1 PRIORITIES

8.1.1 Australian Energy Market Operator's vision

The AEMO 2020–23 Corporate Plan indicates the following (quite generic though) pillars.

1. Reliable and secure system operations: to maintain high-reliability operation of energy systems while adapting to anticipated changes in generation, and improve forecasting services;
2. Future system design: to facilitate among stakeholders an orderly transition to a fit-for-purpose future system through actions like the development of Integrated System Plan and integrate planning across electricity, gas and transport;
3. Adaptive markets and regulations: to implement new approved market requirements, also by working with the Energy Security Board and the Australian Energy Market Commission (AEMC) to evolve rules and market designs;
4. Consumer engagement and access: to empower individuals to exercise choice in the energy market, also by improving public data on choices and outcomes and facilitating energy plan comparisons;
5. Digital and data: to deliver a modern digital platform that will unlock new value for consumers, improve data access, choice and user experience, and enable flexibility and new services.

However, the Australian Energy industry is clearly pointing at strategic priorities such as energy storage, green hydrogen, waste-to-energy / circular economy and off-shore wind.

8.2 STORAGE

The energy storage sector is also starting to pick up momentum, with 22,661 small-scale batteries installed in 2019, taking Australia's household storage capacity past 1 GWh for the first time. And with a further 15 utility-scale batteries under construction and several other projects financially committed at the end of 2019, 2020 promises to be a breakthrough year for batteries in Australia.

State-based programs continue to drive this growth, with South Australia's Home Battery Scheme leading the way. Despite slower than expected uptake and claims that battery prices are still beyond the average homeowner's reach, the Government remains confident that the scheme will reach its goal of 40,000 battery installations in four years. The scheme provides a subsidy of up to $6,000 towards the installation of a battery, which is approximately a quarter of the cost of a standard battery installation.

The pilot of Victoria's Solar Battery Rebate was expanded to more than 100 postcodes in 2019 due to a sluggish initial response from consumers, and next release of battery rebates is in July 2020. Progress towards the Victorian Government's target of 10,000 subsidised battery systems installed via the Solar Homes program (with special assistance in COVID-19 time) over 10 years is expected to ramp up as battery costs and barriers to ownership decrease.

A barrier to ownership was the lack of a consistent national standard to provide battery installers with a consistent set of rules to work to, but the new battery installation standard AS/ NZS 5139 was released in October 2019.

The integration of batteries into Virtual Power Plants will play a crucial role in the renewable energy future by providing better outcomes for consumers and supporting local and regional electricity grids. The Australian Energy Market Commission and the Australian Energy Market Operator have already begun planning for a future in which VPPs play a key role in creating a two-sided national energy market that will enable increased consumer participation. More information about VPP in Chapter 6.7.3.

UTILITY-SCALE BATTERIES UNDER CONSTRUCTION AT THE END OF 2019[75]

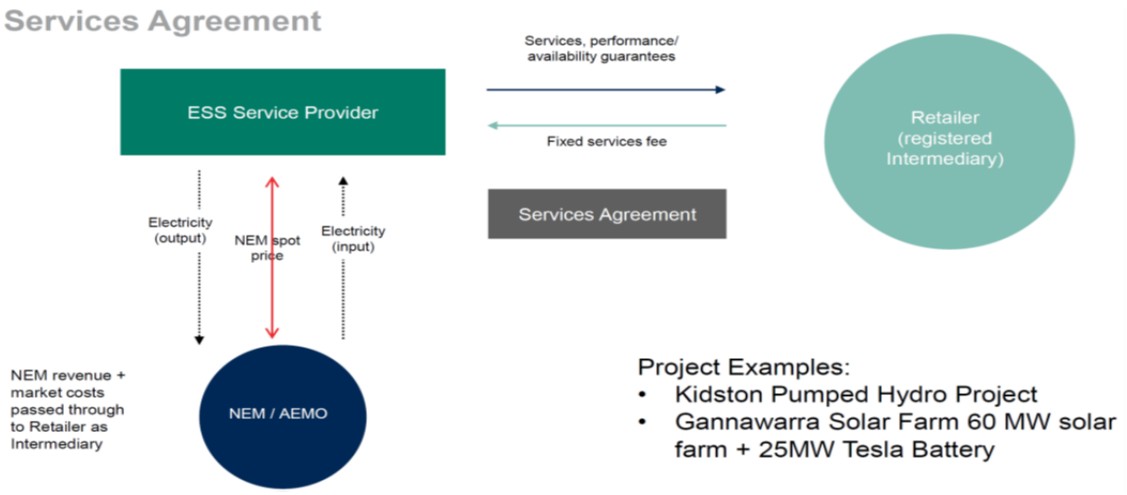
STATE	PROJECT NAME	PROJECT OWNER	LOCALITY	SIZE OF SYSTEM
QLD	Wandoan South BESS	Vena Energy	Wandoan South	100MW/150MWh
SA	Hornsdale Power Reserve Stage 2	Neoen	Hornsdale	50MW/64.5MWh
WA	Chichester Solar Farm	Alinta Energy	Chichester	35MW*
SA	Lake Bonney Wind Farm Battery	Infigen Energy	Millicent	25MW/52MWh
VIC	Bulgana Green Power Hub	Neoen	Joel South	20MW/34MWh
NT	Katherine Solar Farm	Katherine Solar Pty Ltd	Cossack	6MW/3MWh
WA	Kalbarri Microgrid	Western Power	Kalbarri	5MW/4.5MWh
QLD	Bohle Plains	Ergon Energy	Bohle Plains	4MW/8MWh
NT	Darwin LNG Gas Generator Support Battery	Darwin LNG consortia	Wickham	4MW/2MWh
QLD	Kennedy Energy Park	Windlab	Hughenden	2MW/4MWh
WA	Garden Island PV-Battery Microgrid	Department of Defence	Garden Island	2MW/0.5MWh
WA	GMA Garnet Port Gregory Wind-Solar Hybrid	Advanced Energy Resources	Yallabathara	2MW/0.5MWh
NSW	Lord Howe Island Microgrid	Lord Howe Island Board	Lord Howe Island	3.2MWh
VIC	Mallacoota Area Grid Storage	Ausnet	Mallacoota	1MWh
WA	Onslow Microgrid	Horizon Power	Onslow	1MWh

Fifteen large-scale batteries were under construction at the end of 2019, many of which are co-located with solar and wind farms. This is an increasingly common trend as developers look to maximise returns from their wind and solar projects.

At the moment, the Hornsdale Power Reserve (located in South Australia) is the biggest utility-scale battery and Neoen announced the size of the world's largest battery (energy 129 MWh, power 100 MW) will be expanded by 50% (64.5 MWh / 50 MW). Supported by Tesla, the project is expected to further showcase the benefits that grid-scale batteries can provide to the National Electricity Market.
In January 2020, Vena Energy announced that it would construct a 150 MWh / 100 MW battery at its Wandoan South Solar Farm in Queensland. When completed in mid-2021, the battery will the largest in Australia, and Vena Energy indicated that it may look to expand the battery to up to 450 MW of storage capacity in future.
In April 2020, Neoen confirmed plans to build the new world's largest battery near Geelong, Victoria: the battery will be charged from the grid and then act as a backup when demand soars. The proposed $300 million battery will likely be capable of storing more than 500 MWh of power, and deliver an output at least four times as great as the Tesla battery at Neoen's existing Hornsdale Wind Farm in South Australia.

8.2.1 Energy Storage Services (revenue models)

Energy Storage as a Service (ESaaS) allows a facility to benefit from the advantages of an energy storage system by entering into a service agreement without purchasing the system. The operation of the ESaaS system is a unique combination of an advanced battery storage system, an energy management system, and a service contract which can deliver value to a business by providing reliable power more economically.
Recent examples are: a] Genex has signed energy storage services agreement with Energy Australia for the 250 MW Kidston Pumped Storage Hydro Project; b] Vena Energy Australia is negotiating an energy storage services agreement with AGL to sell the storage capacity of a 100MW Battery Energy Storage System at Wandoan.

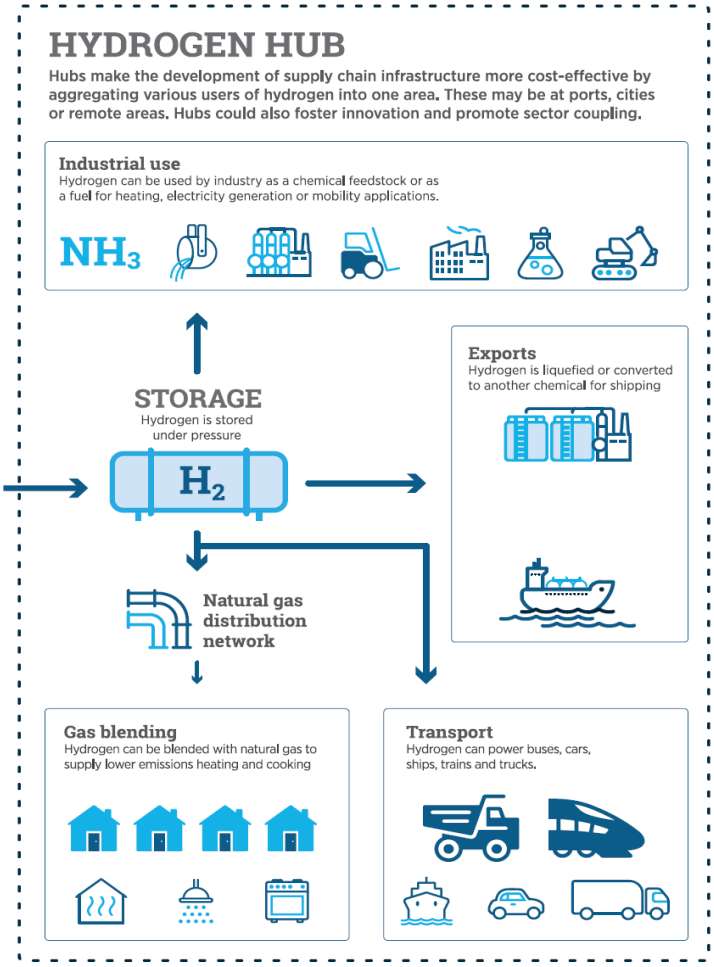


8.3 HYDROGEN

In the last two years, hydrogen as an energy carrier has gained renewed interest in Australia. This has been ignited by policy-driven demand in the Asia Pacific and low-cost renewables. The Japanese and South Korean governments have published strategies for moving towards a hydrogen economy with roadmaps and targets for hydrogen import. Initially, the University of Queensland took the spotlight when the first production and export of green hydrogen from Australia to Japan was achieved in March 2019, and the Japanese conglomerate JXTG used the University's facilities to extract hydrogen from water.

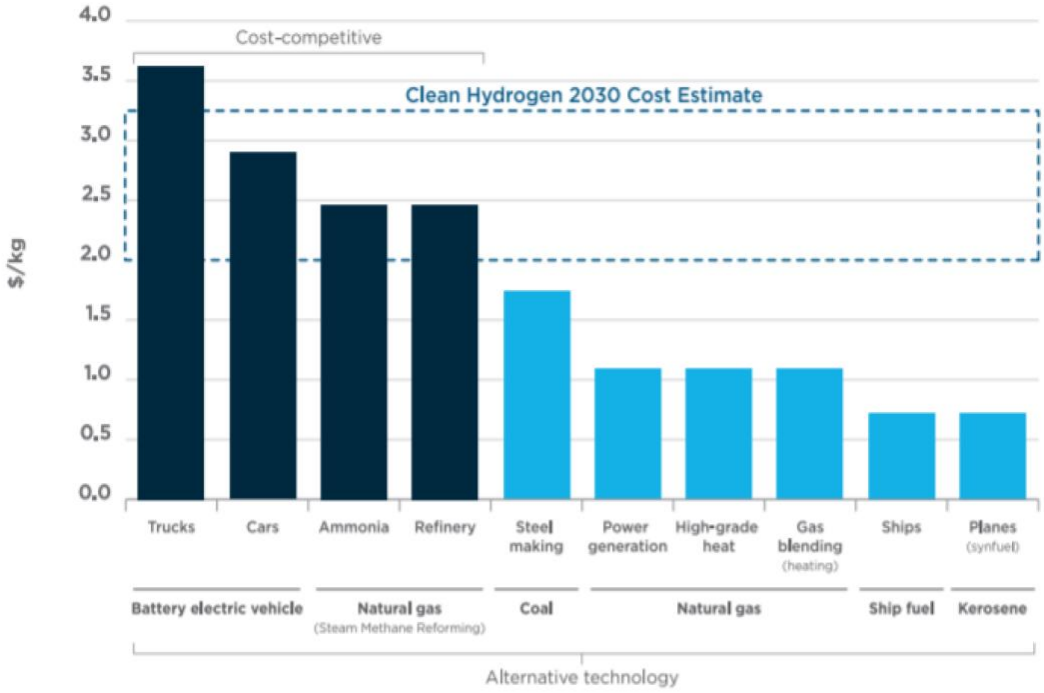
The Council of Australian Governments Energy Council launched the National Hydrogen Strategy in November 2019 as part of a commitment to energy security, reliability and affordability for all Australians. The strategy maps Australia's path to be an industry leader by 2030 by developing a clean, innovative, competitive and safe hydrogen industry for both domestic and export use.
Between 2015 and 2019, the Australian Government committed over $146 million to hydrogen projects, that are helping to learn more about how hydrogen can form part of Australia's energy mix to drive down prices and emissions. In May 2020, the Australian Government established a $300 million Advancing Hydrogen Fund to support hydrogen-powered projects (read more in Chapter 9.1.1).

A key element is to create hydrogen hubs – clusters of large-scale demand: these may be at ports, in cities, regional or remote areas, and will provide the industry with its springboard to scale. Hubs will make the development of infrastructure more cost-effective, promote efficiencies from economies of scale, foster innovation, and promote synergies from sector coupling. These will be complemented and enhanced by other early steps to use hydrogen in transport, industry and gas distribution networks, and integrate hydrogen technologies into the Australian electricity systems in a way that enhances reliability.



The Strategy also aims at securing the investment to develop a globally competitive hydrogen export industry that could be worth up to an estimated $26 billion a year by 2050.

Australian interest in Clean Hydrogen has been bolstered by the falling costs to produce and use hydrogen. Over the past decade, for example, the cost of generating electricity from wind has fallen by about 70%, and from solar PV by about 80%. The cost to make a hydrogen fuel cell, meanwhile, has fallen by about 60% since 2006. With foreseeable technology improvements and higher manufacturing volume, it is anticipated that the cost of fuel cells might fall by about another 30% by 2025. The cost of storing hydrogen will also become cheaper with scale, technology and efficiency improvements (by up to 40% as ammonia and up to 80% as liquid hydrogen). As costs fall, clean hydrogen will become increasingly competitive: when and where this occurs will also depend on factors such as the cost of its alternatives.



This will vary across different uses of hydrogen: in certain sectors, notably transport and industrial uses, the cost gap with other fuels is narrow and competitiveness in Australia appears likely within a decade, as shown in the picture above indicating the estimated cost of hydrogen against alternative technology for major applications in 2030.

8.3.1 State Governments' commitment to green hydrogen

Every State and Territory in Australia has regions with excellent prospects for hydrogen production. Through the National Hydrogen Strategy, all of Australia's Governments are committing to remove barriers to industry development, thanks to nationally consistent and smart regulation, enhanced engagement with customer countries. The Federal Government will track progress and monitor local and overseas emerging industry changes so that all jurisdictions can respond to market developments.

New South Wales is already home to an established hydrogen-based industry and the NSW Government is aware of the high level of investor interest in its hydrogen industry and is assessing the development of supporting infrastructure and capabilities which would eventually underpin a larger scale hydrogen sector, including an export market for North Asia and beyond.

The NSW planning system provides a coordinated framework for State significant projects, including most large hydrogen projects: the establishment of Special Activation Precincts (SAPs are one of the focus areas of the $4.2 billion Snowy Hydro Legacy Fund) in NSW offers a mechanism that can align with the development of hydrogen hubs in regional areas. Examples:

- the Jemena Western Sydney Green Gas Project that involves designing and constructing a Power-to-Gas facility which will convert solar and wind power into hydrogen via electrolysis;
- "Project NEO" from Infinite Blue Energy, that in May 2020 has revealed a new strategy to transition large fossil fuel users in NSW to green hydrogen to assist the state's companies to de-carbonise. The initial target for this project is 1 GW of 100% Green Hydrogen reliable baseload power via a combination of solar PV, wind turbines and hydrogen fuel cell technology. Project NEO, which will commence with a feasibility study and detailed design by the end of 2021, is focused on transitioning the traditional reliance on coal fired and/or gas fueled electricity to green hydrogen-generated baseload electricity.

Local governments and community groups across Victoria have already identified opportunities for hydrogen-based projects on a local and regional level. The Victorian Hydrogen Investment Program is supporting the development of a green hydrogen industry through market testing, policy development and a targeted investment program.
The world's first fully integrated Hydrogen Energy Supply Chain pilot project in Victoria is demonstrating a full supply chain starting with hydrogen production from brown coal in the Latrobe Valley and ending with its transportation to Japan. The four year (2018–2021) HESC pilot project includes the transportation of liquified hydrogen in a world-first, purpose-built liquified hydrogen carrier. The delivering consortium consists of Kawasaki Heavy Industries, Electric Power Development Co., Iwatani Corporation, Marubeni Corporation, Sumitomo Corporation and AGL. A commercial HESC requires a low-CO2 hydrogen energy supply chain, with the carbon sequestration solution provided by the CarbonNet project (described in Chapter 8.4).

The Queensland Hydrogen Industry Strategy (2019–2024) sets a vision that 'by 2030, Queensland is at the forefront of renewable hydrogen production in Australia, supplying an established domestic market and export partners with a safe, sustainable and reliable supply of hydrogen.'. The Strategy includes the $15 million Hydrogen Industry Development Fund, providing funding for investors developing hydrogen projects in Queensland.
In 2019, Queensland signed a Memorandum of Understanding with the Japan Oil, Gas and Metals National Corporation to cooperate on hydrogen and a Statement of Intent with the University of Tokyo's Research Center for Advanced Science and Technology. The Queensland Government's Redlands Research Facility will establish the Hydrogen Process Research and Development Project.

While Western Australia remains the only state without a renewable energy target, in July 2019 the State released the Western Australian Renewable Hydrogen Strategy detailing vision, goals and implementation pathways required for WA to be a significant producer, exporter and user of renewable hydrogen. The $10 million Renewable Hydrogen Fund aims to facilitate private sector investment, providing financial support for feasibility studies and capital works projects. Examples:

- The $3.53 million ATCO's industry leading Clean Energy Innovation Hub is a test bed for solar PV, battery storage, hydrogen production and hydrogen blending with natural gas, as it incorporates production, storage and use of hydrogen produced by solar powered water electrolysis.

Then the hydrogen is injected into a demonstration gas network and is also being tested in a fuel cell generating electricity as well as a direct and blended combustion fuel for domestic appliances.

- Stage One of the Infinite Blue Energy Liquid Hydrogen Project will be the Arrowsmith Project, located in Western Australia: this installation will commence production in 2022 resulting in 25 tons (25,000 kg) of green Hydrogen per day from the zero carbon energy sources of water, solar and wind.

The Government of South Australia was the first jurisdiction to publish a hydrogen strategy, in 2017, and to date has committed more than $40 million in grants and loans to the development of hydrogen projects. Building on this investment, the government released South Australia's Hydrogen Action Plan in 2019, setting out the next steps for the development of the State's hydrogen industry. A key commitment of the Action Plan is the development of a SA Hydrogen Export Modelling Tool to inform the establishment of renewable hydrogen export supply chains.
The Hydrogen Regulatory Working Group is currently supporting 3 MW-scale projects the SA Government has co- invested in with over $40 million in grants and loans:

- Hydrogen Park South Australia from Australian Gas Networks;
- Renewable hydrogen and green ammonia supply chain demonstrator from The Hydrogen Utility;
- Hydrogen Superhub from Neoen Australia.

Following the Tasmanian Renewable Hydrogen Action Plan, the Government is actively working with a range of proponents to facilitate investment in renewable hydrogen production for both domestic use and export, with a focus on developing the Bell Bay Advanced Manufacturing Zone as a hydrogen hub.

8.4 CARBON CAPTURE AND STORAGE / UTILIZATION

Following many years without being clearly indicated as a valid option in lowering Australian emission, Carbon Capture and Storage has (unexpectedly) been included in the recently released discussion papers of the "Energy Technology Investment Roadmap" (see Chapter 7.1). The Federal Government is considering legislative changes to allow its clean energy agencies to fund carbon capture and storage from fossil fuel projects in a bid to unlock $2 billion of potential private investment to reduce greenhouse gases.

Despite multiple CCS demonstration projects at Australian coal-fired power stations, none of Australia's coal plants are currently capturing CO_2 or have a timeframe for doing so. However, the Carbon Capture and Storage Flagships program supports a small number of demonstration projects that will capture carbon dioxide emissions from industrial processes, provide transport infrastructure (generally pipelines) and safely store carbon dioxide underground in stable geological formations.

Victoria is actively pursuing opportunities to use its brown coal resource in new ways, consistent with the Statement on Future Uses of Brown Coal: the production of hydrogen from brown coal, when coupled with CCS presents a significant opportunity and comparative advantage for Victoria. The conveniently located CarbonNet Project could enable production of clean hydrogen for domestic and export markets. The CarbonNet project investigates the potential for a large scale CCS network in the Gippsland region of Victoria: the network could cover multiple sources of carbon dioxide captured from industrial plants or power stations, that would then be transported via a shared pipeline and injected offshore in a deep sub-sea storage formation. CarbonNet is managed and co-funded by the Victorian Government and the Australian Government, that has committed $95.2 million to the current phases of project.

8.5 WASTE-TO-ENERGY AND CIRCULAR ECONOMY

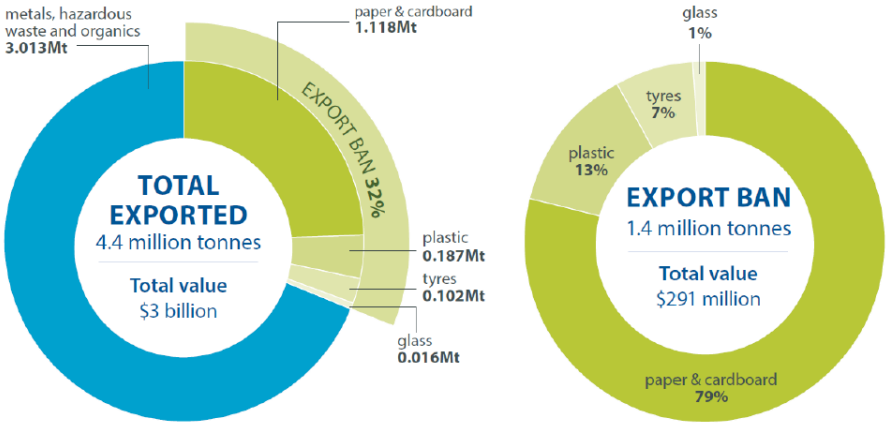
8.5.1 Waste export ban

In 2019 Federal, State and Territory governments agreed that plastic, paper, glass and tyres waste that had not been processed into value-added materials should be progressively banned from export from Australia by no later than 30 June 2022, starting in 2020.

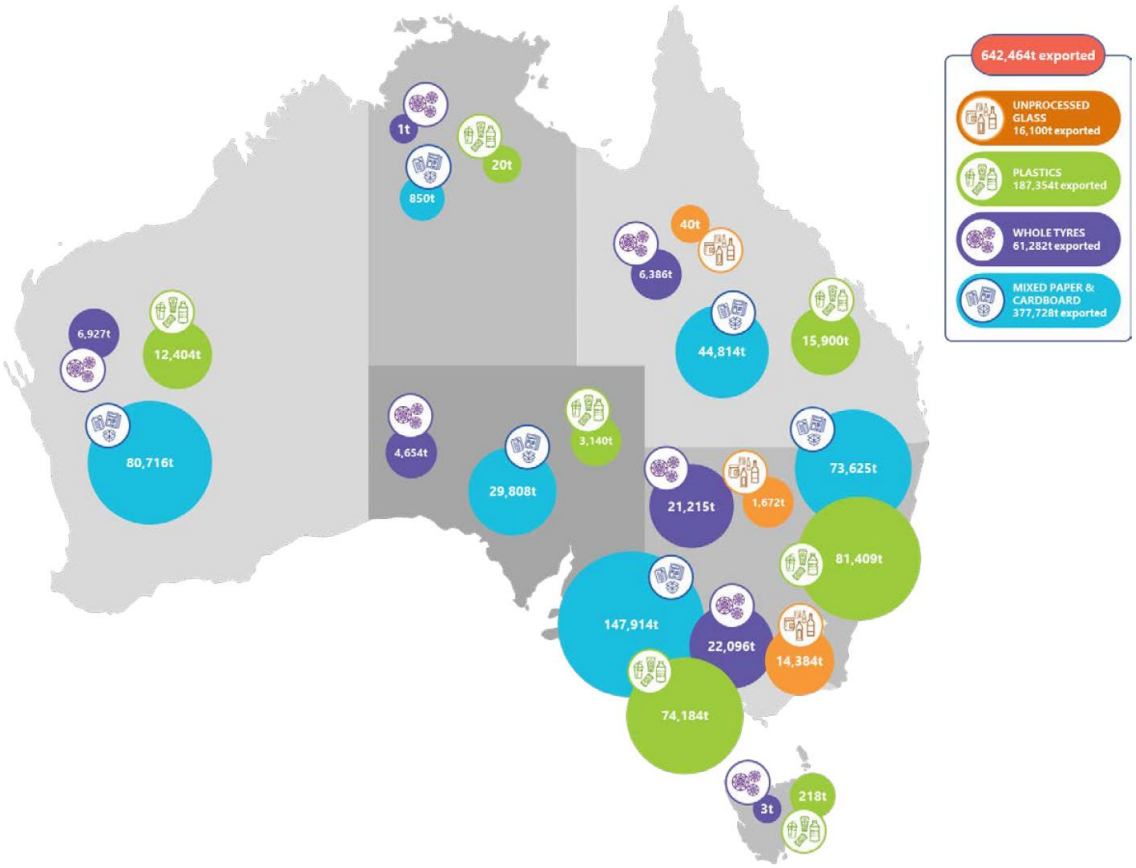
Changes in waste import standards in countries around the world have highlighted the need for Australia to manage its own waste better. In 2018, China introduced new restrictions on the recyclable materials it imports through China's National Sword Policy. Australia is one of over 100 countries affected by China's restrictions: China was Australia's largest export market for waste, receiving approximately 4% (1.3 million tonnes) of Australia's recyclable waste and around one-third of Australia's recyclable plastics, paper and cardboard. Following China's decision, other countries (including India, Indonesia and Malaysia) raised concerns about the standards of recyclable materials they were importing.

Prior to the restrictions, Australian recycling facilities received $225 - $250 per tonne for paper and plastics sold to China. The current price now sits at around $50 per tonne and this significant reduction in export price has left many recycling facilities unprofitable.

Australians create around 67 million tonnes of waste each year. In 2018-19, 4.4 million tonnes of this waste was exported: this included 1.4 million tonnes of plastic, paper, glass and tyres waste, representing 32% of total waste export tonnage, as per picture below:



Here below a picture indicating Australian waste exports and in-cope waste volumes per State and Territories in 2018-2019.



In 2019 Australia was recycling 58% of generated waste. Although there was a need to improve recycling rates, some recyclable materials in Australia were already in oversupply (i.e. stockpiles of tyres and glass): these stockpiles were posing a significant risk to the environment and human health, as it was important to avoid this waste going to landfill.

Other market challenges in Australia's waste management, recycling and manufacturing sectors included unreliable supply of recyclable materials that were ready for re-manufacturing and costs of virgin materials often being lower than costs of recycled material.
There were also big differences in the infrastructure available to manage waste, recycle materials and manufacture products containing recyclable material across Australia's States and Territories and between metropolitan, rural, regional and remote areas. Further modernisation of Australia's recycling infrastructure was considered necessary to improve recovery rates and create more opportunities for re-processing and re-manufacturing recyclable materials.

8.5.2 National Waste Policy and beyond

The National Waste Policy (November 2019) presents targets and actions that will guide investment and national efforts to 2030 and beyond, addressing also the impediments to a circular economy.
The national targets can be summed up as per the following list:
1. Ban the export of plastic, paper, glass and tyres waste, commencing in the second half of 2020
2. Reduce total waste generated in Australia by 10% per person by 2030
3. 80% average resource recovery rate from all waste streams following the waste hierarchy by 2030
4. Significantly increase the use of recycled content by governments and industry
5. Halve the amount of organic waste sent to landfill by 2030

In March 2020 the Council of Australian Governments released a response strategy presenting a coordinated and ambitious package to implement the 2019 waste export ban, including action in the following key areas: driving demand for recycled content, public education to reduce contamination at its source, investment in recycling and waste infrastructures.

In early July 2020, the Federal Government announced $190 million funding towards new recycling infrastructure, as it looked to divert more than 10 million tonnes of plastic, paper and glass waste away from landfill. The funding, contingent on State and Territory Governments and industry groups matching the federal contribution, is part of a newly launched Recycling Modernisation Fund that the Government hopes to generate $600 million in investment. In addition to the $190 million, the federal government confirmed the allocation of $24.6 million on improving waste data to better track recycling targets, as well as $35 million towards implementing its commitments under the National Waste Policy Action Plan. The objective was that this "targeted investment will grow Australia's circular economy, create more jobs and build a stronger onshore recycling industry".
However as a result of a Covid-19 induced legislative backlog, the first deadline as part of the proposed waste export ban has been pushed back, beginning with a ban on exporting glass waste from 1 January 2021, which had originally been planned to take effect from the second half of 2020.

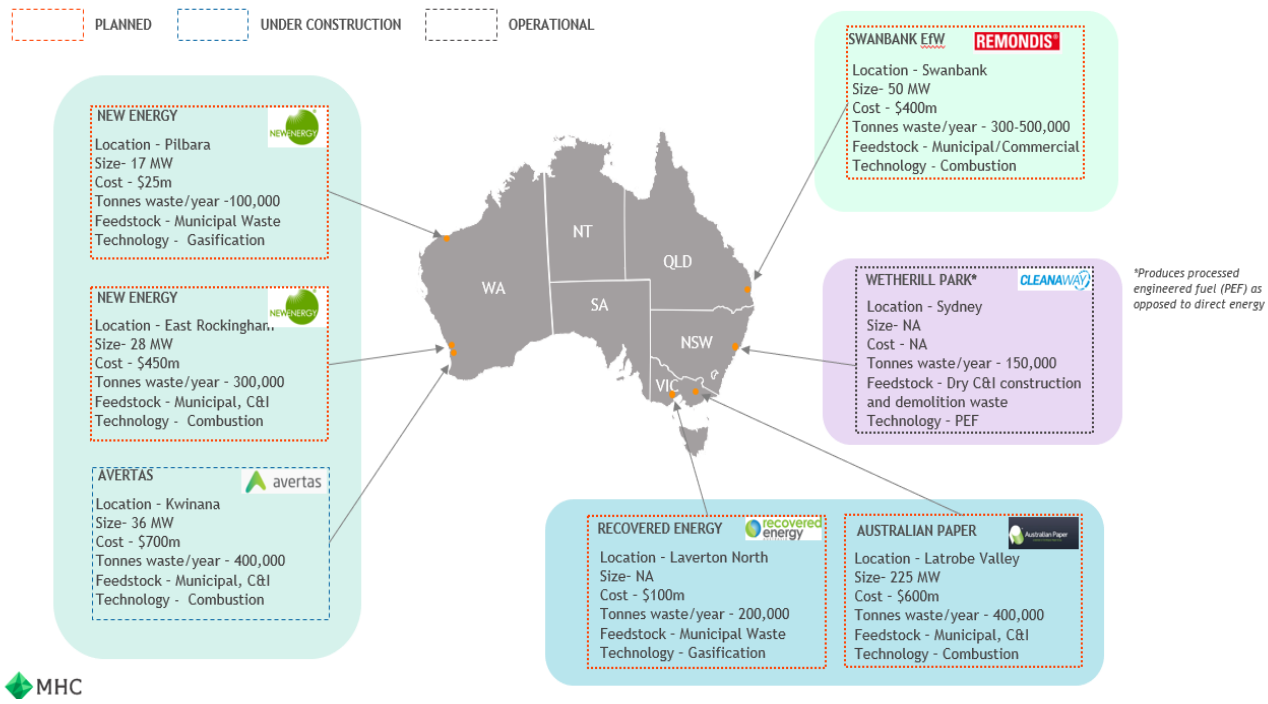
8.5.3 Waste-to-Energy technology

Australia generates nearly 70 million tonnes of waste per year, around half of which is recycled (and approx. 40% is sent to landfill). There's a multitude of different coloured bins outside residential and commercial buildings and traditionally this rubbish would be all destined for landfill and recycling stations, but now some companies are taking cues from innovations in Europe and investing in ways to extract energy from Australian waste.

Australia's landfills are reaching capacity and forcing leaders to find new solutions, including one that involves turning waste into electricity, with the view that the results will help to reduce waste-levels while also creating bio-energy and a sustainable fuel.
"Where you can possibly reuse, recycle you should do it," says Mac Irvine, acting head of Waste and Bioenergy for Australia-based Clean Energy Financing Corporation. "But if it gets to the point where it would go to a landfill, then this technology is a better alternative. It is not a silver bullet to curing the world's waste issue, but it does prevent tons of municipal solid waste that would otherwise go into landfill."

Australia's waste sector is undergoing an important transition, requiring significant investment in infrastructure and equipment, including upgrades to existing assets, as well as the installation of new assets. Through the $100 million Australian Recycling Investment Fund, the focus is on large-scale projects which use clean energy technologies to support the recycling of plastics, paper, glass and tyres waste.
However, Waste-to-Energy, whilst a well-established technology for municipal waste disposal and energy generation in comparable jurisdictions, is relatively immature on a large scale in Australia, one of the main reasons being the fact that local communities consider waste incineration not good for the environment and their health.

In Victoria, there are various small to medium organic waste conversion facilities including Yarra Valley Water's Aurora facility, which is a medium scale anaerobic digestion facility converting 30,000 tonnes of commercial food waste into energy annually, and the Waranga Green Energy's project to convert biomass (piggery effluent) into renewable energy. However, while there are a number of project proposals, and a large-scale thermal WtE plant that is currently under construction in Kwinana, there is not yet a single operating plant that can recover energy from municipal solid waste.



The first waste-to-energy plant in Australia - The Kwinana Waste to Energy project will develop a waste processing facility to process approximately 400,000 tonnes of municipal solid waste, commercial and industrial waste and/or pre-sorted construction and demolition waste per annum to produce approximately 36 MW of baseload power for export to the grid. The project will use Keppel Seghers's moving grate technology, which thermally treats waste and converts the recovered energy into steam to produce electricity. Metallic materials will be recovered and recycled, while other by-products will be reused as construction materials. It will be the first thermal utility-scale Waste to Energy facility constructed in the nation, diverting approximately 25% of Perth's post-recycling rubbish from landfill sites.

The second waste-to-energy plant got green light: Spanish renewable energy leader Acciona will work with Hitachi Zosen Inova (HZI) on a $515 million project to build the 29 MW waste-to-energy plant in the Rockingham Industrial Zone, 45 Km South of Perth, that will have capacity to power 40,000 homes from an annual feedstock of 300,000 tonnes of municipal, industrial and commercial rubbish. Long term contracts have been put in place to source household refuse from nearby local council collections, and Suez has committed to supply 65,000 tonnes of non-hazardous industrial and commercial waste. Together with HZI, Suez has also signed a 20 year agreement to operate and maintain the facility, which will be jointly owned by a consortium of investors that includes John Laing, HZI and ACCIONA.

According to a report from Infrastructure Partnerships Australia, considering recent international waste market disruptions, Australia's waste management system needs a clear, nationally coordinated and forward-looking response. The decisions made by the COAG provide some clarity around national objectives on waste management, but more work is required by governments of all levels. Appetite among community and industry stakeholders to reform the waste sector is growing also in response to decreasing tolerance for landfill and increasing social awareness of related issues. This is occurring in conjunction with large infrastructure operators and investors providing significant capital and expertise to meet Australia's waste challenges.

Waste management and circular economy strategies have been released – either in draft or final form – over the past 12 months by the State Governments in New South Wales, Victoria, Queensland, Western Australia and Tasmania. However, there is still a lack of clarity and consistency about waste management technologies in these Government plans: only some strategies (most notably the final advice by Infrastructure Victoria) openly address WtE and steps required to support its implementation.
In March 2020 the Metropolitan Waste and Resource Recovery Group (supporting Melbourne's 31 metropolitan councils to to minimise waste and maximise resource recovery)called for expressions of interest for solutions to provide an alternative to landfill for 16 councils in Melbourne's South-East: the shortlisted companies (Veolia Environmental Services Australia, Sacyr Environment Australia and Pacific Partnerships and REMONDIS) will develop an advanced waste processing solution as an alternative to landfill. It is expected that the process will take close to two years to reach a final tender stage and a 20 to 25-year contract will be awarded by 2022, with construction of new facilities starting in 2023.

Emissions standards are another key component of the regulatory framework for WtE facilities. In the European Union, there are currently over 450 WtE facilities in operation and emissions are tightly regulated through the EU Industrial Emissions Directive. Noting that Victoria and Western Australia have already implemented the EU standards, adoption across all States and Territories should be applied through nationally consistent regulation.

Therefore, in absence of a national policy, State and Territories Governments are tackling the WtE agenda in different ways. For example, in early June 2020, the Australian Capital Territory has ruled out any incineration of waste under a new ACT Waste-to-Energy Policy 2020-25, developed to move towards its 90% resource recovery by 2025, stating "The policy establishes underlying principles and outcomes to guide the transition to a circular economy and provides clear direction about the types of activities that are permitted.". According to the policy, new facilities, proposing thermal treatment of waste (by means of incineration, gasification, pyrolysis) will not be permitted in the ACT, while the waste hierarchy will be respected and recycling won't be undermined.

Moreover the lack of a nationally coordinated approach means that, even if investors and operators can proceed with an WtE facility in one jurisdiction, developing similar projects in other jurisdictions will require a whole new approach.

8.5.4 Circular economy

The transition to a circular economy represents an ambitious movement towards a low-waste, high-resource-efficiency future. Elements of the circular economy have been in play for many years in Australia: cleaner production programmes, waste to landfill levies (see Chapter 6.5.1), collection and recycling of household packaging and paper, metals recycling, regional waste strategies, infrastructure planning and investment, waste and recycling legislation and other regulatory interventions under State-based environment protection acts.

Below are two examples of State policies supporting a shift away from the current linear economic model based on the 'take-make-dispose' approach to managing products and resources:

- Queensland's new Waste Management and Resource Recovery Strategy, underpinned by a waste disposal levy, provides the strategic framework for Queensland to become a zero-waste society, where waste is avoided, reused and recycled to the greatest possible extent. The strategy focuses on transitioning to the principles of a circular economy to help retain the value of material in the economy for as long as possible. It provides the framework to help deliver coordinated, long-term and sustained growth for the recycling and resource recovery sector while reducing the amount of waste produced and ultimately disposed of, by promoting more sustainable waste management practices for business, industry and households. The necessity of the Strategy was triggered by an absence of policy certainty and strategic direction, that inhibited investment in the recycling and resource industry: in particular, insufficient investment in recycling and resource recovery infrastructure has restricted Queensland's ability to improve waste recovery performance. As a result, it has become clear that improved on-shore reprocessing capacity is necessary to contend with a growing stock of recyclable materials.

- The state of Victoria is still suffering from a recycling crisis, partly due to the insolvency of SKM Recycling in 2019, contracted to manage the waste of 31 local councils in Victoria, that led to the transfer of more than 4,600 tonnes of recyclable material to landfill in a single week.
  Recycling Victoria: A new economy is the Victorian Government's 10-year circular economy policy and action plan to fundamentally transform the state's recycling sector, by investing more than $300 million in a suite of landmark reforms dedicated to shifting Victoria to a circular economy. Greater separation of recyclable materials and investment in the right infrastructure will produce higher-quality recycled materials with stronger market demand.

A clearer understanding of where the recycling ends up will support a recycling system that communities and businesses can rely on.

The policy released in March 2020 is based on strategic reforms (examples):

- ✓ Kerbside reform - Changing how Victorians recycle so that materials collected from households are high quality and can be used again to make new products.
- ✓ Stronger recycling oversight - New Act and new waste authority to make the recycling system reliable and transparent.
- ✓ Waste-to-energy – The Government will encourage investment in appropriate waste-to-energy facilities that reduce the need for landfills.
- ✓ Reducing business waste - A new Circular Economy Business Innovation Centre will help businesses reduce waste and generate more value with fewer resources.
- ✓ Invest in priority infrastructure - Victoria will have the right infrastructure to support increased recycling, respond to new bans on waste export and safely manage hazardous waste.

The Victorian Government will support early entrants into Victoria's waste to energy market, including facilities that use organic waste to make bioenergy or provide precinct-scale energy. Investment support will include grant or loan funding and investment facilitation to help proponents navigate regulatory and financial processes. The government will also fund research to develop safe end uses for the residual products (like ash and digestate) of waste to energy facilities.

A change in landfill levies will be introduce as well, as Victoria has currently one of the lowest landfill levies for municipal and industrial waste in the country, risking to make Victoria a dumping ground for waste coming from other States: landfill levy for metropolitan household and business waste will increase up to $125.90 per tonne over the next three years, with proportional increases reflected at regional landfills. This progressive increase of the landfill levy rate will support the social, economic and environmental value of recycling, and so a shift to a circular economy.

Exponential technologies like AI, IoT, and robotics will be the key enablers in helping Australia transition to a circular economy. AI will be integral in optimising supply chains and assessing the condition of products returned to manufacturers for repair, refurbishment, or dismantling. IoT sensors will provide ongoing usage analytics and signal the best time to repair or replace componentry with minimal downtime for customers. Finally, advanced robotics will enable the analysis of materials required for speedy repairs, refurbishment, or breakdown of products into valuable componentry and resources.

KPMG prepared a report investigating the potential economy-wide pay-off of transitioning to a more circular economy in Australia (with focus on key sectors such as Food, Transport and the Built Environment), taking into consideration Australian-specific circular opportunities to estimate economy-wide impacts for Australia. The document estimates that a future circular economy in the indicated sectors would represent a potential economic benefit of $23 billion in present value GDP by 2025. By 2048, KPMG estimates that the benefit of a circular economy will likely rise to a present value of $210 billion in GDP and an additional 17,000 full-time equivalent jobs for Australia. Opportunities such as energy efficiency in dwellings and food waste reductions represent the greatest impacts in dollar terms: the former, for example, is estimated to increase the output of the dwellings sector by 3.2% by 2048.

8.6 OFF-SHORE WIND

The bushfires that ravaged Australia in late 2019 and early 2020 crystallised the growing concerns of most Australians over climate change. The country was already facing major challenges over the need to reshape its energy sector given the impending closure of all existing coal-powered generators by 2048, which provide the majority of electricity in Australia, and the demands of a population that's predicted to double to 50 million by 2050.

In that light, it was timely that on 3 January 2020 the Australian Government released a Discussion Paper for a proposed Offshore Clean Energy Infrastructure regime (specifically including offshore wind), signaling the intent to provide a framework for development of this relatively new (at least to Australia) technology, with only the 2.2 GW Star of the South advancing off the Victoria coastline currently putting the nation on the global offshore wind map.
The regulatory framework will be developed to enable the exploration, construction, operation and decommissioning of offshore wind and other clean energy technologies and associated infrastructure in Australian waters (beyond three nautical miles from the coast). The Federal Minister with responsibility for energy matters will make all major decisions under the framework, that will recognise all offshore users and balance competing interests through consultation and negotiation. The first step in this process is the requirement for the Minister to consult over an area that may be potentially suitable for offshore clean energy infrastructure development. The consultation and any subsequent declaration would take place before any licence for progressing development can be awarded. The declaration stage is designed to identify and prevent potential conflicts in competing interests, and set conditions before a project could progress, such as key stakeholders and consultation requirements, constraints on types of activities. After consideration of the results of the consultation process the Minister may declare an area as suitable for offshore clean energy projects. Following a declaration, the Minister may open applications to seek competitive interest in a declared area for commercial and / or non-commercial activities.
It is proposed to leverage the experience of the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) to operate as the regulator for any new industry.

The Government Discussion Paper is a very positive signal that Australia is ready to investigate and legislate to promote and regulate this industry, but the question remains whether Australia can move quickly enough to exploit an incredible opportunity that is being recognised in other nations competing for infrastructure investment capital.

With 85% of Australia's population living within 50km of the coastline, the potential for offshore wind should be more obvious than other forms of energy where the resource is located much further away from its intended market, and often with little chance of actually transmitting resultant electricity via a clogged grid to the final customer. Offshore wind provides many benefits to a transitioning energy system that go beyond the mere supply of electricity. These include:

- Amenable connection to transmit electricity to the market given that the central grid is located close to coal mines and generators which are in proximity to Australia's coastline;
- Greater energy supply and network reliability, given the less intermittent generation of offshore wind and a profile that often meets Australian peak demand periods;
- Possible transition of workers from traditional fossil-fuel based industries that may suffer from impending closures over the coming decades.

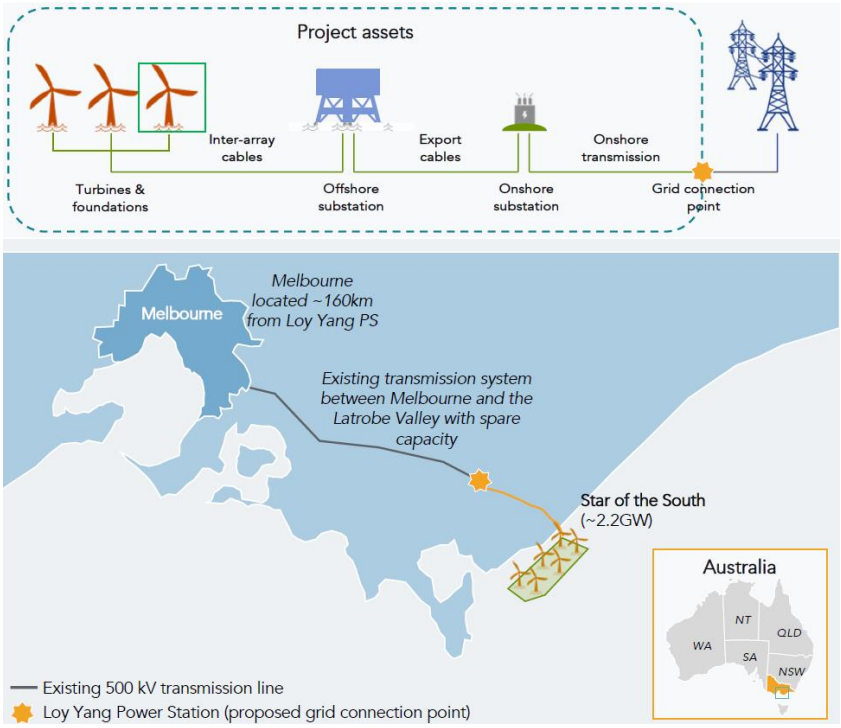
8.6.1 Star of the South offshore wind project

The Star of the South offshore wind farm will further boost the wind sector's credentials, with feasibility studies underway to assess the viability of the wind farm off Port Albert near the Gippsland region of Victoria (a 496km2 area in Bass Strait). The Star of the South operates under an exclusive exploration licence, which was approved by the Australian Government in March 2019: the licence is for exploration activities only and is valid for five years, with a possible extension of two years.

With the expectation that the project will feed 2,200 MW of clean energy into the grid, the offshore wind farm will require the installation of an undersea cable to link to existing transmission infrastructure in the nearby Latrobe Valley, Victoria's coal power generation hub. The 200 wind turbines planned would generate up to one-and-a-half times the energy of the now-closed Hazelwood coalfired power station.

- Australia's first offshore wind project
- Located in Gippsland
- 2.2GW installed capacity
- Powering up to 1.2 million homes
- Around 20% of Victoria's electricity needs
- Reliable, consistent, environmentally-friendly
- Currently in the feasibility phase
- Detailed and formal approval processes

StaroftheSouth



9. FUNDING

A range of Government grant programs are available to assist companies with funding energy efficiency projects, with eligibility requirements that can differ significantly across programs and jurisdictions. Funding sources also include co-financing packages, loans, tax incentives and other innovative financing solutions, with many designed to support transition to a low carbon economy or to help overcome barriers to energy efficiency uptake.

On top of dedicated Federal, State and Local Governments' funding and grants, an important source of capital can be traced to agencies like Clean Energy Finance Corporation and the Australian Renewable Energy Agency. In order to unlock more funding, industry experts recently recommended an "expanded, technology-neutral remit" for these two agencies, so they could attract more private investment in a wider range of technologies outside renewables, such as coal or gas-fired power incorporating carbon capture and storage. This would be a significant change to the remit of these agencies, which were set up to promote the development of renewable wind and solar supplied to the electricity grid, as changing the legislation would enable the $1 billion Grid Reliability Fund to be invested in new gas, hydrogen and coal projects relying on carbon capture.

The Climate Solutions Fund was set up in 2015 with $2.5 billion funding to pay polluters to employ cleaner technologies and to fund carbon capture through tree planting, soil carbon sequestration on farms and energy efficient systems in commercial properties, as well as methane capture from landfill and waste management. In 2019, the Federal Government topped up the fund with another $2 billion. To date, it has issued 450 contracts to abate a cumulative 190 million tonnes of carbon at a total cost of $2.3 billion.

According to Energy and Emissions Reduction Federal Minister, "The government will target Dollar-for-Dollar co-investment from the private sector and other levels of government to drive at least $4 billion of investment that will reduce emissions across Australia".

9.1.1 Clean Energy Finance Corporation

CEFC invests in projects related to Renewable Energy, Built Environment and Sustainable Economy. With regard to Renewable Energy, CEFC considers innovations and solutions for:

- ✓ Solar – Working alongside a diverse range of global and Australian financiers and investors, the objective is to deliver large-scale projects that support reliability and stability of electricity supply. CEFC's commitments (with $1.1 billion already invested) since inception are on track to deliver 1.6 GW of new large-scale solar in Australia.
- ✓ Energy Storage – CEFC collaborates with project proponents to deliver energy storage projects in order to integrate clean energy into the electricity grid. The agency is providing significant investment to improve transmission system flexibility, balancing technologies, such as pumped hydro, battery storage and providers of system strength such as synchronous condensers.
- ✓ Bioenergy – CEFC has invested in several market-leading bioenergy projects and is working with industry to help increase market understanding about the potential uses and benefits of bioenergy, supporting the 'reduce, reuse, recycle' recommendations of the international waste hierarchy.

- ✓ Hydrogen – The $300 million Advancing Hydrogen Fund supports the growth of a clean, innovative, safe and competitive Australian hydrogen industry. CEFC finance has the potential to drive large-scale deployment of electrolyser technologies (leading to technology cost reductions, improved supply chain expertise), catalyse the hydrogen industry (to accelerate the deployment of large-scale renewable energy hydrogen technologies, including demand-side projects to achieve price discovery), access to tailored finance (providing investing support to project proponents as they seek to accelerate hydrogen developments) and support the implementation of the National Hydrogen Strategy (Chapter 8.3). Projects seeking CEFC finance through this Fund are required to be based on renewable energy, energy efficiency and/or low emissions technologies, including those that advance hydrogen production and develop export and domestic hydrogen supply chains (i.e. hydrogen export industry infrastructure and establishment of hydrogen hubs).
- ✓ Wind – CEFC investments in large-scale wind projects have tracked a remarkable level of innovation and change in the sector, with hybrid projects that bring together wind, solar and energy storage. Wind energy opportunities are demonstrating increasing market maturity, but there are still factors that limit investor appetite: CEFC can work alongside global and Australian investors to address these challenges with tailored finance solutions designed to help accelerate Australia's transition to a low carbon economy.

9.1.2 Australian Renewable Energy Agency

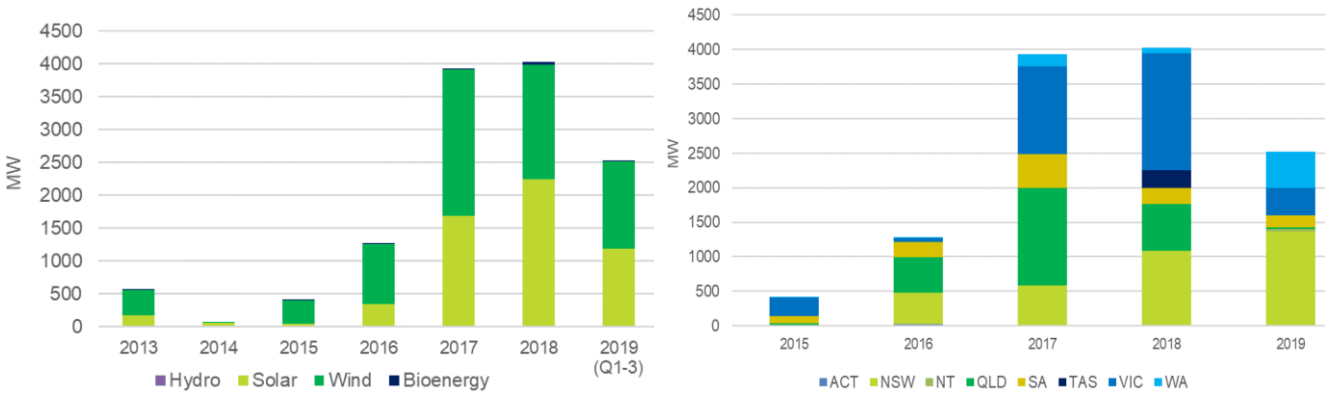
From research to large-scale deployment, ARENA funding spans the entire innovation chain, accelerating the affordability of new technologies and building investor confidence in renewable energy projects in Australia. As at 31 March 2020, ARENA had $92 million available to commit to new projects: despite ARENA's projects pipeline exceeding this amount and whilst not all of the projects will be successful in seeking funding, it is expected that ARENA's funds will be fully committed by the end of 2020.

- ✓ ARENA's Advancing Renewables Program supports a broad range of development, demonstration and pre-commercial deployment projects that can deliver affordable and reliable renewable energy.
- ✓ An opportunity is offered by the Renewable Hydrogen Deployment Funding Round, providing up to $70 million in funding to support the acceleration of hydrogen. The Round can receive expressions of interest for projects which: demonstrate electrolysis and associated renewable hydrogen technologies at scale, facilitate a pathway to technical and commercial viability of renewable hydrogen in Australia, provide price discovery and transparency in relation to the current and projected economics for renewable hydrogen technologies.
- ✓ ARENA and CEFC are collaborating on the Clean Energy Innovation Fund, the largest dedicated cleantech investor in Australia, created to invest $200 million in early-stage clean technology companies. The Innovation Fund targets technologies and businesses that have passed beyond the research and development stage and which can benefit from early stage seed or growth capital to help them progress to the next stage of their development.

As the agency's funding is expected to be exhausted by the end of 2020, before its scheduled wind-up in 2022, the Clean Energy Council is "calling on the Government to extend the life of ARENA for at least another decade, and to equip the agency with at least $2 billion over that time to ensure it can continue its work in accelerating the clean energy transition.".

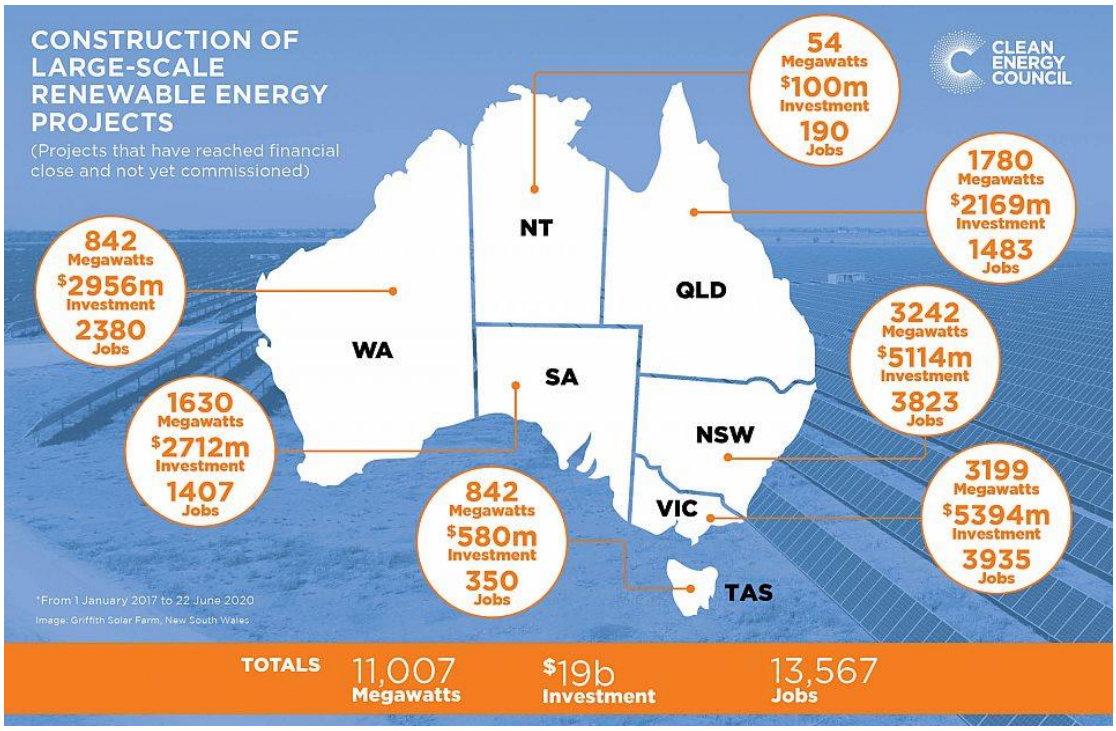
10. PROJECTS IN CONSTRUCTION AND COMMITTED

The market indicated a stall in new project commitments in 2019, with clear differences in a State by State analysis.



Source: Green Energy Markets (All-Energy Australia, October 2019)

Nevertheless, according to the Clean energy Council, the renewable energy sector is experiencing unprecedented activity across Australia in 2020: based on projects that have reached financial close and are not yet commissioned, there are currently 95 large-scale renewable energy projects in construction (or due to start construction soon), that will deliver over $19 billion in capital costs, 11,007 MW of new renewable energy capacity and create 13,567 direct jobs.



Projects in construction or due to start soon by technology:

- Wind 5,844 MW
- Solar 5,975 MW

Number of projects in construction or due to start soon by State:

- NSW 29
- NT 4
- QLD 13
- SA 14
- TAS 2
- VIC 21
- WA 12

Projects completed (commissioned) by year:

- 2017 11 projects 1,013 MW
- 2018 27 projects 1,565 MW
- 2019 42 projects 2,621 MW
- 2020 9 projects 623 MW (7 large-scale solar farms and 2 wind farms)

If this rate of installation growth continues, it is estimated that Australia's energy mix could reach 50% renewables by 2025.
An analysis by the ANU Energy Change Institute suggests that the Australia energy industry has now demonstrated the capacity to deliver 100% renewable electricity by the early 2030s.

[Please contact FIT Melbourne for the list of the ten major projects in construction or due to start]

11. BIBLIOGRAPHY

- ✓ Electricity Distribution in Australia (IBISWorld, March 2019)
- ✓ Electricity Retailing in Australia (IBISWorld, March 2019)
- ✓ Electricity Transmission in Australia (IBISWorld, May 2019)
- ✓ Hydro-Electricity Generation in Australia (IBISWorld, January 2020)
- ✓ Gas Supply in Australia (IBISWorld, May 2020)
- ✓ Liquefied Natural Gas Production in Australia (IBISWorld, October 2019)
- ✓ Petroleum Refining and Petroleum Fuel Manufacturing in Australia (IBISWorld, April 2020)
- ✓ Solar Electricity Generation in Australia (IBISWorld, May 2020)
- ✓ Solar Panel Installation in Australia (IBISWorld, June 2019)
- ✓ Wind and Other Electricity Generation in Australia (IBISWorld, May 2020)
- ✓ Wind Farm Construction in Australia (IBISWorld, December 2019)

- ✓ APA opens new solar farm in its Western Australian renewables precinct (PV Magazine, 4 December 2019)
- ✓ Australia hits record-breaking energy storage capacity (SunWiz, 10 March 2020)
- ✓ Australia's National Hydrogen Strategy (COAG Energy Council, 22 November 2019)
- ✓ Battery of the Nation report (Hydro Tasmania, 2019)
- ✓ Bioenergy state of the nation report (KPMG, November 2018)
- ✓ Clean Energy Council Report 2020
- ✓ Clean energy found to be a pathway to prosperity for Northern Territory (The Guardian, 20 June 2019)
- ✓ Discussion paper on implementing and Response strategy to implement the August 2019 decision of the Council of Australian Governments (COAG, November 2019 and March 2020)
- ✓ DOE Hydrogen and Fuel Cells Program Record (United States Department of Energy, 2017)
- ✓ Hydrogen: The Economics of Storage (Bloomberg New Energy Finance, 2019)
- ✓ Hydrogen opportunity for Australia (McKinsey, 2019)
- ✓ Insights from the Australian-German Energy Transition Hub (September 2019)
- ✓ Forget coal, the new roadmap is a gas guzzler (AFR, 23 May 2020)
- ✓ Future of Energy: Australian energy outlook report (PwC, 2019)
- ✓ Government looks to carbon capture for climate action (SMH, 19 May 2020)
- ✓ Green Building (Green Building Council of Australia, October 2019)
- ✓ Making the Australian circular economy a reality (Deloitte, 20 January 2020)
- ✓ National Waste Policy – Action Plan 2019
- ✓ New plan to transition NSW to green hydrogen by 2027 (Energy Magazine, May 2020)
- ✓ NSW Electricity Strategy (NSW Government, November 2019)
- ✓ "Offshore wind is a golden opportunity Australia can't afford to miss" (Recharge, February 2020)
- ✓ Potential economic pay-off of a Circular Economy (KPMG, April 2020)
- ✓ Putting Waste to Work report (Infrastructure Partnerships Australia, 2020)
- ✓ Recycling Victoria: A new economy (Victoria Government, March 2020)
- ✓ Renewable energy is growing but NSW and Queensland are still undershooting their targets, (ABC News, 10 July 2019)
- ✓ South Australia's stunning renewable energy transition, and what comes next (Renew Economy, 5 November 2019)

- ✓ South Australia unveils plan for 100% renewable hydrogen economy (Renew Economy, 24 September 2019)
- ✓ Coalition announces $190m plan to divert 10m tonnes of waste from landfill (The Guardian, 6 July 2020)
- ✓ Victorian solar industry in crisis as August solar homes rebates run out within hours (Clean Energy Council, 1 August 2019)
- ✓ Virtual Power Plant demonstration in Australia (Energy Storage News, 3 April 2020)
- ✓ WA opens $10m hydrogen fund to boost renewable gas production and exports (Renew Economy, 18 September 2019)
- ✓ Waste Management and Resource Recovery Strategy (Queensland Government, 2020)

Date of publication: July 2020