

The renewable energy sector in Australia



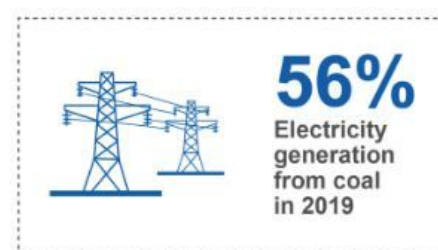
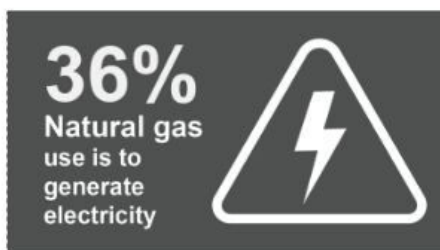
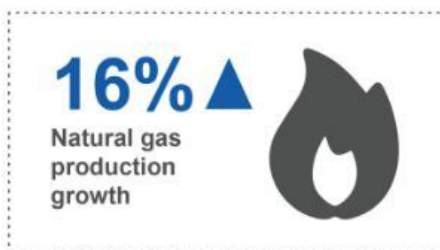
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Overview

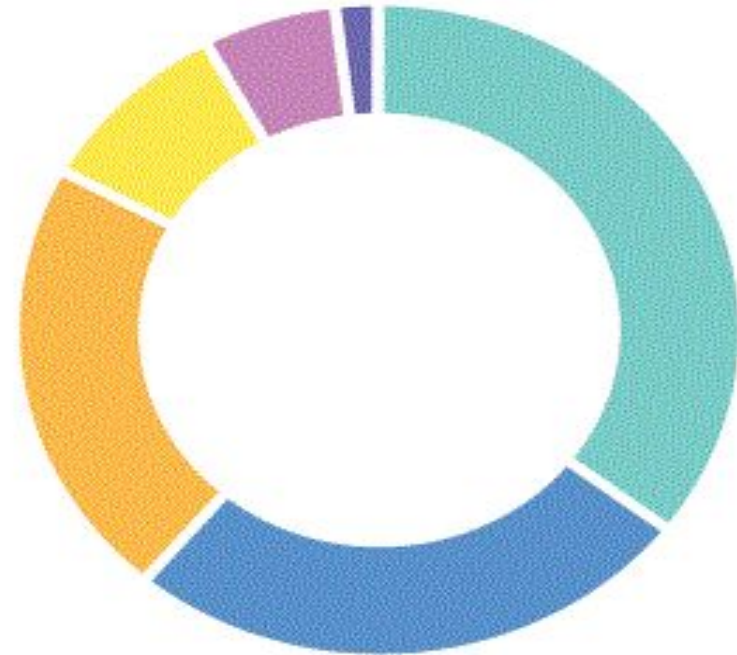
- Renewable energy was responsible for 24 % of Australia's total electricity generation in 2019
- Renewable Energy Target (RET) achieved;
- 34 large-scale projects completed in 2019, delivering additional 2.2 GW and generating \$4.3 billion in investment;
- For a brief period, renewables passed the 50 per cent mark of total generation in the National Electricity Market in November.





The renewable mix

- Wind (35%) overtook hydro (26%) as Australia's leading clean energy source;
- Rooftop solar industry smashed last year's record of 1.6 GW to break the 2 GW milestone for the first time;
- Solar power counts for 33 per cent (aggregated)



Wind	35.4%
Hydro	25.7%
Small-scale solar	22.3%
Large-scale solar	9.3%
Bioenergy	6.0%
Medium-scale solar	1.3%



TECHNOLOGY	GENERATION (GWh)	% TOT GENERATION	% RENEWABLE GENERATION	HOUSEHOLDS POWERED
Wind	19,487	8.50%	35.4%	4,240,013
Hydro	14,166	6.20%	25.7%	3,082,150
Small-scale solar (< 100 KW)	12,269	5.30%	22.3%	2,669,440
Large-scale solar (> 5MW)	5,141	2.20%	9.3%	1,118,596
Bioenergy	3,314	1.40%	6.0%	721,005
Medium-scale solar (100 KW - 5MW)	716	0.30%	1.3%	155,867
TOT	55,093	23.90%	100.0%	11,987,070



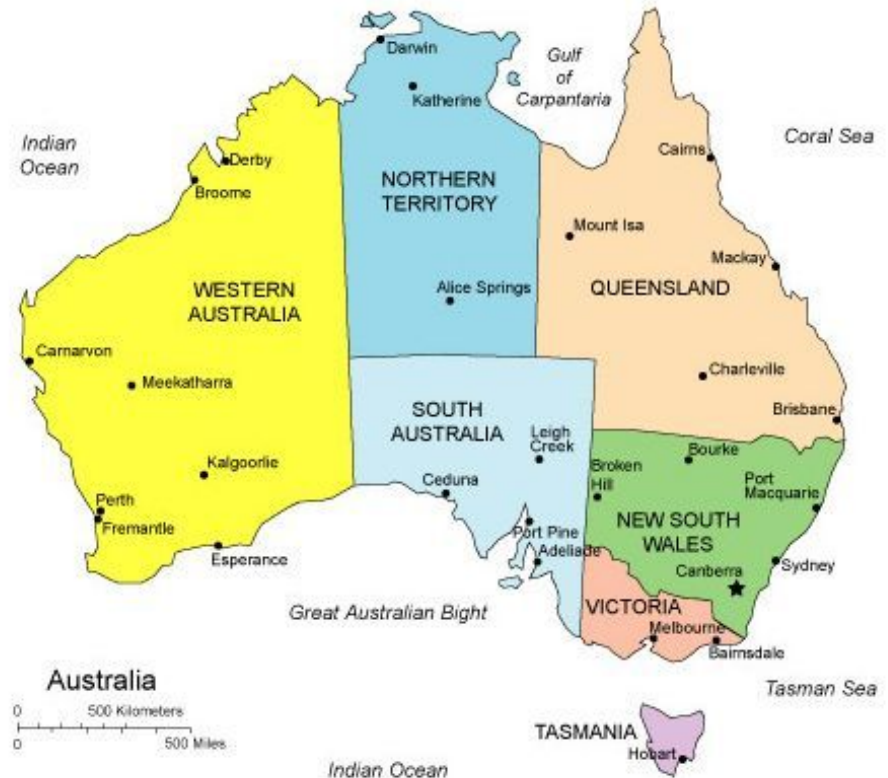
Largest projects completed 2019

TECH	STATE	OWNER	PROJECT	CAPACITY (MW)
Wind	NSW	AGL PARF	Silverton Wind Farm	200
Wind	QLD	Mount Emerald Wind Farm	Mount Emerald Wind Farm	180
Solar	QLD	Edify Energy	Daydream Solar Farm	150
Hybrid	WA	APA Power Holdings	Badgingarra Renewable Facility	147.5
Solar	NSW	John Laing	Finley Solar Farm	133
Wind	SA	ENGIE	Willogeleche Wind Farm	119
Solar	QLD	Palisade Investment Partners	Ross River Solar Farm	116
Wind	NSW	Bodangora Wind Farm	Bodangora Wind Farm	113
Solar	QLD	APA Group	Darling Downs Solar Farm	110
Solar	QLD	Lilyvale Asset Co	Lilyvale Solar Farm	100
Solar	QLD	Pacific Hydro	Haughton Solar Farm	100
Solar	VIC	Neoen	Numurkah Solar Farm	100
Solar	SA	Arcadia Energy Trading	Tailem Bend Solar Farm	95
Solar	VIC	BayWa r.e.	Karadoc Solar Farm	90
Solar	NSW	New Energy Solar	Beryl Solar Farm	87
Wind	VIC	Pacific Hydro	Crowlands Wind Farm	80
Solar	QLD	Clermont Asset Co	Clermont Solar Farm	75
Solar	QLD	Adani	Rugby Run Solar Farm - Stage 1	65
Solar	QLD	Edify Energy	Hayman Solar Farm	50



Outlook

- By 2040, two thirds of coal-fired power generation is likely to be retired;
- By 2035 there may be periods where nearly 90 per cent of demand is met by renewable generation;
- Gas could play a larger role, but only if the prices remained low .



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Political context

- In 2017 Turnbull launched the NEG (National Energy Guarantee) policy to reduce 2005 emissions by 26 % by 2030;
- At the April 2019 federal elections:
 - Labor party target 50 % renewable energy target by 2030 and net zero emissions by 2050;
 - Coalition (Liberal and National Party) offered only a top up of the Emissions Reduction Fund;
- The Coalition won the election;
- Notable shift in public sentiment in Early 2020 after devastating bushfires;



Federal Policy

- Renewable Energy Target (RET) and energy certificates: 33,000 gigawatt-hours (GWh) target met in 2019;
- The roles of:
 - ARENA Australian Renewable Energy Agency
 - Australian Research Council
 - CSIRO Commonwealth Scientific and Industrial Research Organisation;
 - CEFC Clean Energy Innovation Fund;
- The Government has recently (Sep-20) announced a technology roadmap that gives more space to renewable energy, however it doesn't commit on any specific target;

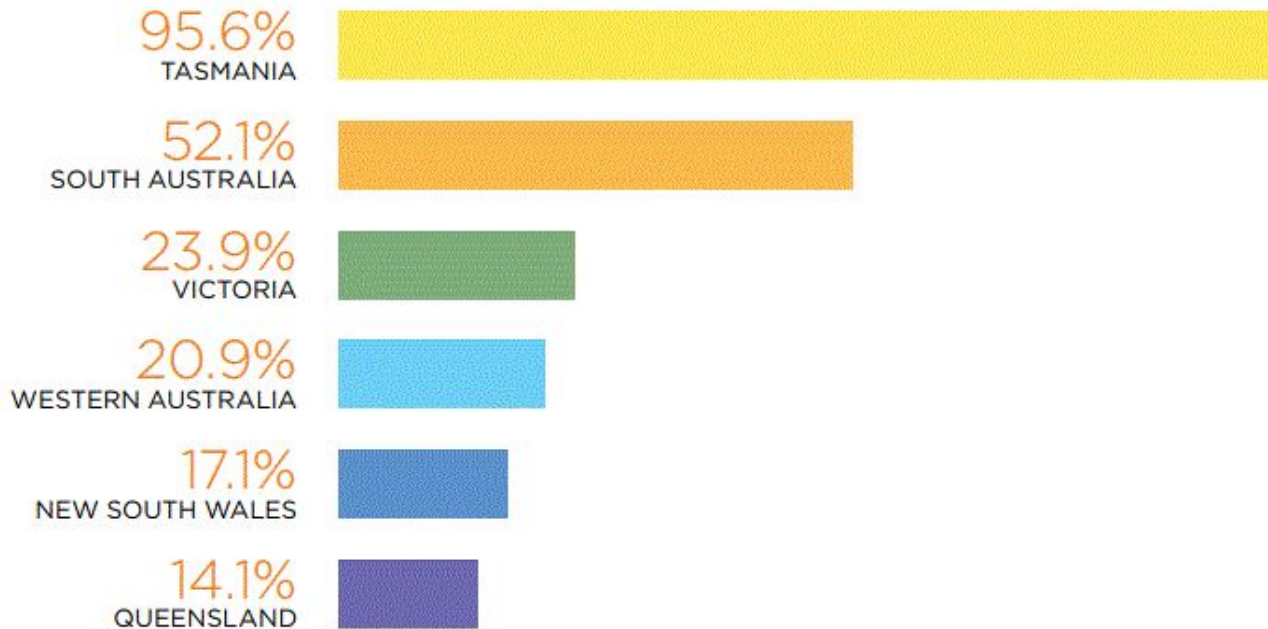


Technology Roadmap

- \$18 billion Investments over 10 years into projects that could reduce carbon emissions;
- Five priority technologies:
 - **clean hydrogen ;**
 - **electricity from storage;**
 - **low-carbon steel and aluminium;**
 - **carbon capture and storage;**
 - **soil carbon sequestration;**
- The roadmap includes new investment in gas fields and gas-fired power, especially in NSW;
- New role for the Agencies (low emissions)



States Policies



- States and territories are developing their own energy agendas;
- Results vary substantially amongst states (14%-100%):
 - Differing natural resources of each region;
 - Variations in historical commitments to support renewable energy.



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Australian Capital Territory



- 100 % of its energy needs from renewable sources;
- 2045 zero net emissions target;
- Launched additional renewable energy reverse auction
- Now focusing on the two largest sources of emissions: transport (60 %) and gas usage (22%).





New South Wales



- 17.1 % of the state's energy from renewable sources;
- 2050 zero net emissions target;
- plan to create 3 REZs (renewable energy zone) with 3000 MW of investment
- Electricity strategy focused on affordability;
- \$102 million investment to upgrade the QLD-NSW interconnector to transfer 190 MW.



Northern Territory

- 8 % of the electricity sourced from renewables;
- 2050 zero net emissions target;
- Committed to gas generation and exports ;
- Planning the largest solar farm in the world (\$20 billion project)
- Major project status for Aus /Singapore power link





Queensland



- 14.1 % of the energy from renewable sources;
- 50 per cent renewable energy target by 2030;
- Over-generation and negative prices in 2019;
- Regulatory attempts to slow down the solar development;
- CleanCo trading on the NEM;
- 100 MW of new renewable generation by 2025;



South Australia

- Over 52 % of power sourced from renewable energy;
- 100 % renewable energy target by 2030;
- lowest electricity prices in the country for the latter part of 2019;
- SA-NSW interconnector given major project status;
- Tesla : Hornsdale Power Reserve (150MW)
- Exploring hydrogen generation (Port Lincoln and Neoen Crystal Brook);





Tasmania



- 95.6 % of power sourced from renewable energy (mostly hydro);
- “Battery of the Nation” ambition;
- Marinus Link Project: a new 1500 MW transmission cable across the Bass Strait;
- UPC Renewables 2 new wind farm projects, able to generate up to 1 GW



Victoria

- 23.9 % of power sourced from renewable energy;
- 50 percent renewable target by 2030 (law);
- Solar Homes Program with rebates;
- Battery home program ;
- KerangLink transmission line between NSW and Victoria to access Snowy 2.0
- VRET 2.0





Western Australia



- 20.9 % of power sourced from renewable energy;
- no emission cut target;
- Asian Renewable Hub grows to 15 GW;
- Horizon Power using stand-alone solar systems for remote customers
- \$10 million Renewable Hydrogen Fund (mix hydrogen with gas);



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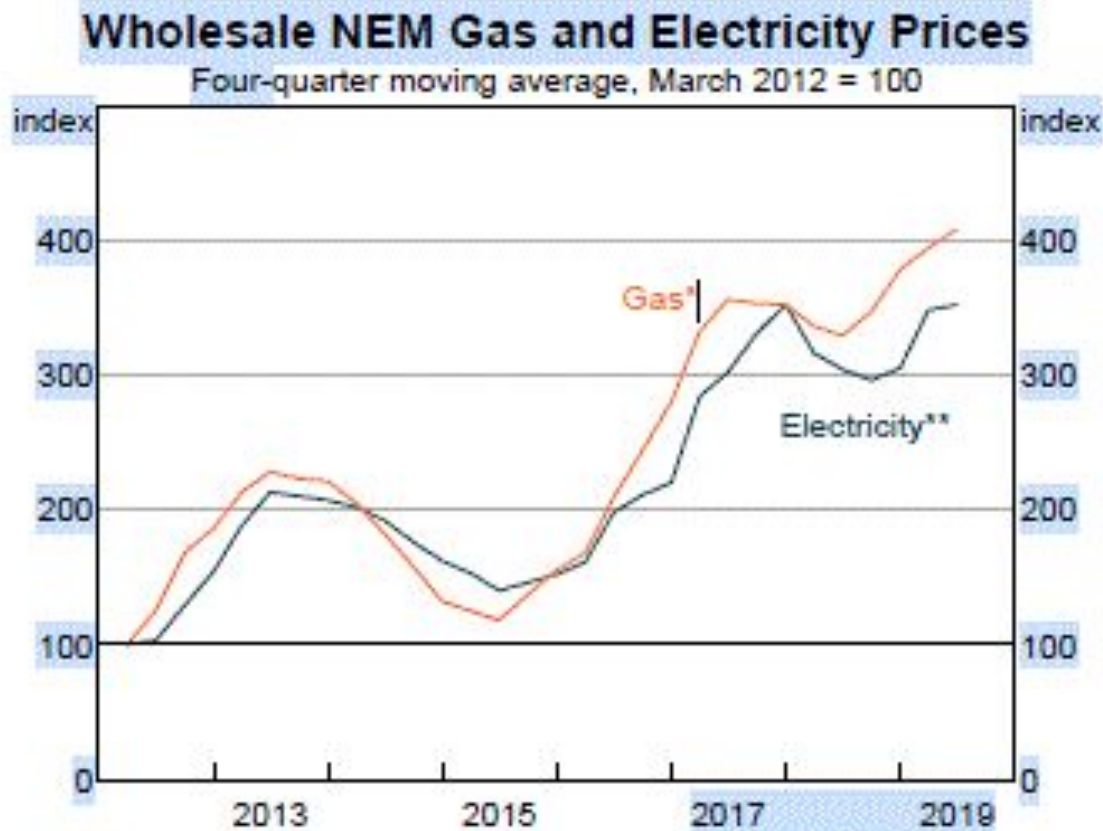


Transmission and Integration



Wholesale electricity prices

- The closures of two brown coal-fired plant - Northern in SA (2016) and Hazelwood in VIC (2017)- had a notable impact on supply (5% of capacity)
- The higher prices of gas and black coal has increased the cost of electricity generation





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Renewable Energy Grid Integration

- Existing transmission grid is old and not adequate to renewable energy production and fluctuation;
- Wind and solar plants are often in remote areas, with limited grid capacity;
- 2016 SA state-wide blackout





Transmission Projects / 1

- The Australian Energy Market Operator (AEMO) released a new Integrated System Plan (ISP) last July;
- Over 15 potential projects to strengthen the transmission grid, with nine of them classified as priority, and total investment budget of at least \$5 billion.



Transmission Projects / 2

1. SA System Strength Remediation;
2. QNI Minor Interconnector;
3. Western Victoria Transmission Network Project;
4. VNI Minor Interconnector;
5. Project Energy Connect;
6. HumeLink Interconnector;
7. Central-West Orana REZ Transmission Link;
8. VNI West, a new interconnector between Victoria and NSW;
9. Marinus Link.



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Technologies



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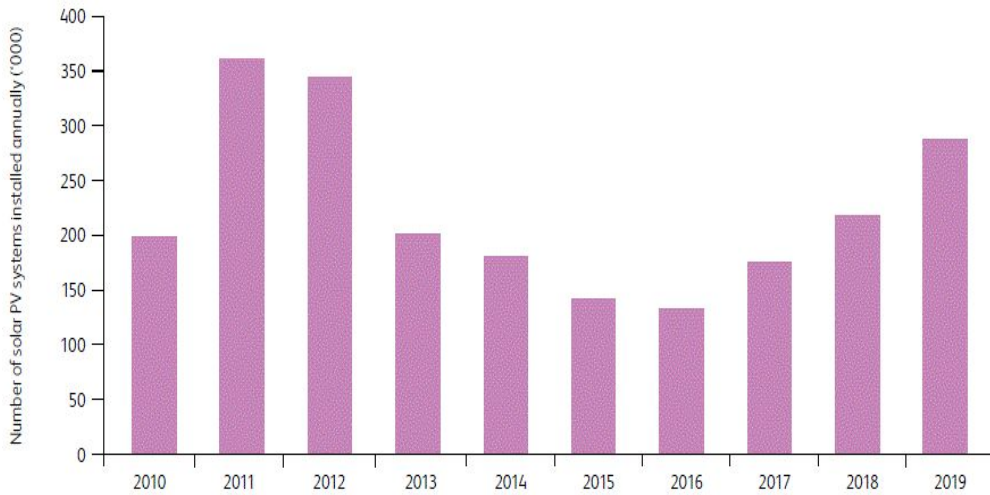
Small scale Solar (up to 100 Kw)

- Rooftop installations passed the 2 GW milestone (2.2);
- 287,504 rooftop solar installations in 2019;
- QLD has four of the top five solar postcodes in Australia ;
- Australia's total rooftop solar potential is 179 GW, more than Australia's current demand;
- Around half of the solar potential lies in residential zones

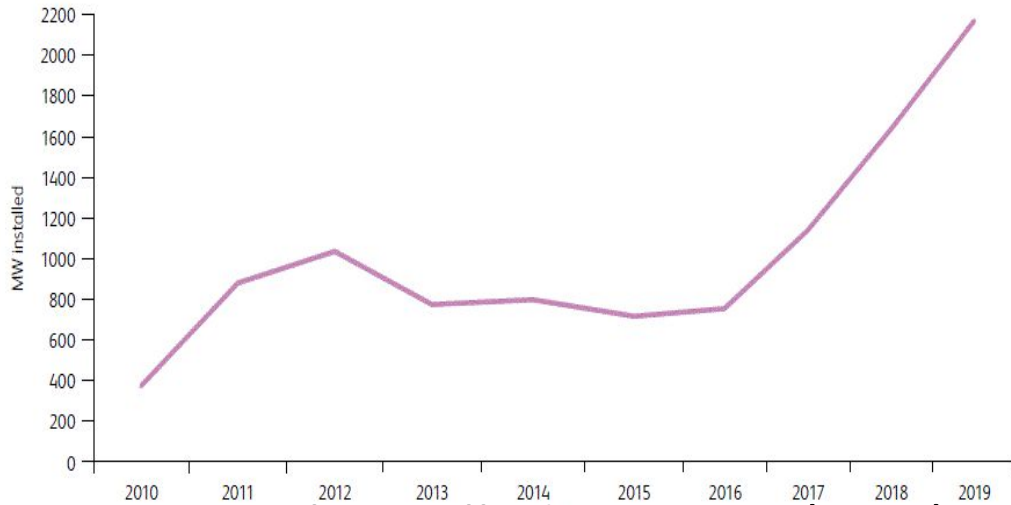




Small Scale PV data



Annual PV installation



Annual installed capacity (MW)

Average PV size

year	KW
2010	1.97
2011	2.42
2012	3.02
2013	3.95
2014	4.44
2015	4.99
2016	5.64
2017	6.38
2018	7.19
2019	7.62



New regulations

- Incentive programs are highly regulated;
- The number of Approved Solar Retailers increased from 166 to 686 in 2019;
- The number of Clean Energy Council accredited installers increased from 5,864 to 6,566;
- New Energy Tech Consumer Code will come into effect in 2020.



Large scale Solar

- 27 projects completed in 2019 with 1.416 MW new capacity added;
- 2.8 GW total large-scale solar capacity in Australia.
- 89 projects under construction or committed in 2019;
- solar contribution to Australia's renewable energy generation increased from 3.9 % to 9.3 % in 2019;
- Under planning the world's biggest solar farm in NT.





New solar plants (commissioned in 2019)

PROJECT	OWNER	STATE	CAPACITY
Daydream Solar Farm	Edify Energy	QLD	150
Finley Solar Farm	John Laing	NSW	133
Ross River Solar Farm	Palisade Investment Partners	QLD	116
Darling Downs Solar Farm	APA Group	QLD	110
Numurkah Solar Farm	Neoen	VIC	100
Lilyvale Solar Farm	Lilyvale Asset Co	QLD	100
Haughton Solar Farm	Pacific Hydro	QLD	100
Tailem Bend Solar Farm	Arcadia Energy Trading	SA	95
Karadoc Solar Farm	BayWa r.e.	VIC	90
Beryl Solar Farm	New Energy Solar	NSW	87
Clermont Solar Farm	Clermont Asset Co	QLD	75
Rugby Run Solar Farm - Stage 1	Adani	QLD	65
Hayman Solar Farm	Edify Energy	QLD	50



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10 largest solar farms active



Project/Location	State	MW	Operated by
Limondale Solar Farm	NSW	349	Innogy
Bungala Solar Power Project	SA	276	Reach Energy
Daydream Solar Farm	QLD	180	Edify Energy
Coleambally Solar Farm	NSW	188	Neoen
Finley Solar Farm	NSW	175	John Laing Group
Sun Metals Solar Farm	QLD	151	Sun Metals
Ross River Solar Farm	QLD	148	ESCO Pacific, Palisade
Darling Downs Solar Farm	QLD	137	APA Group
Tailem Bend Solar Power Project	SA	127	Vena Energy
Nevertire Solar Farm	NSW	130	Elliott Green Power



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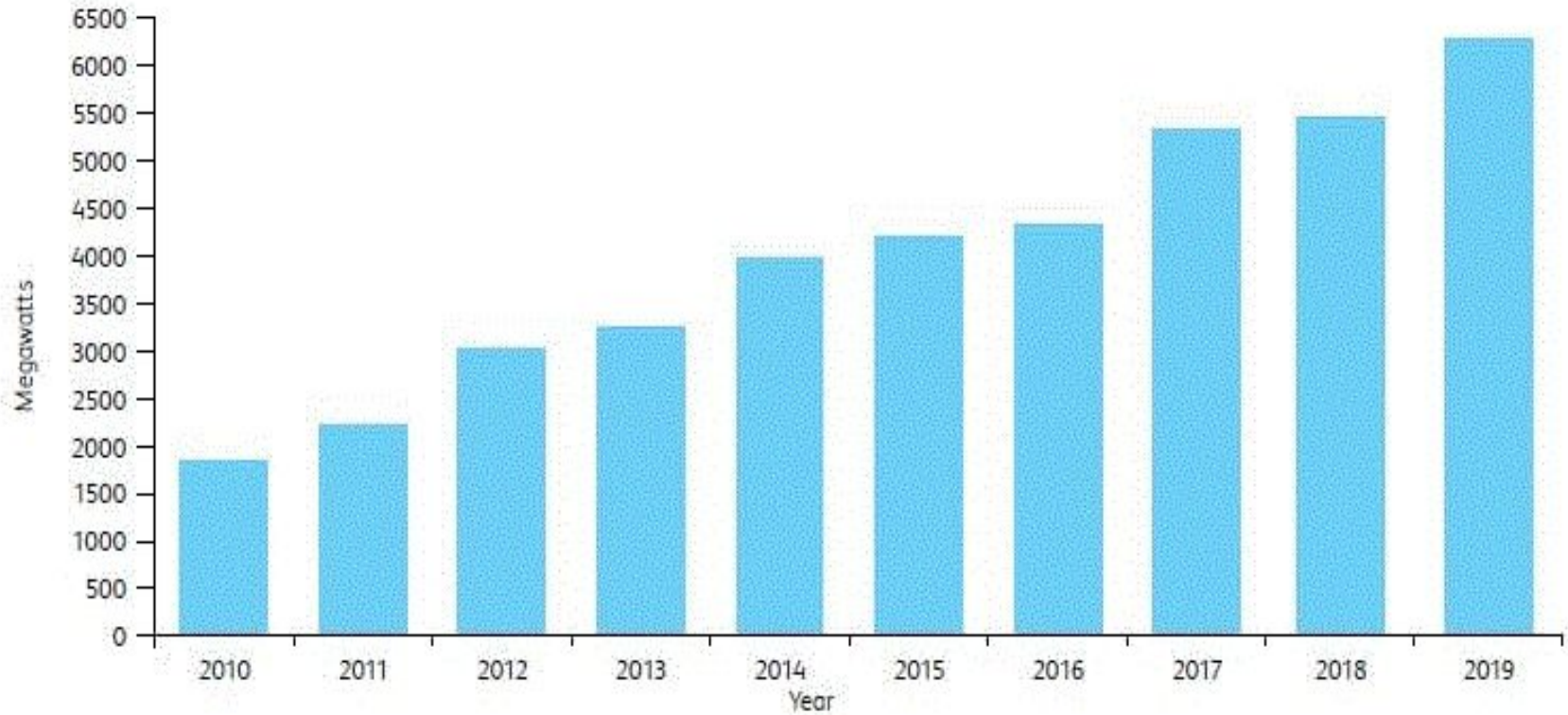
Wind

- 60% of the new projects being built
- 27 new wind farms under construction or financially committed will provide the majority of new capacity;
- 8 new wind farms commissioned in 2019
- 837 MW of new wind capacity installed in 2019
- The largest was AGL's 200 MW Silvertown Wind Farm in north-western NSW.





Cumulative installed wind capacity



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



New wind farms (commissioned in 2019)

PROJECT	OWNER	STATE	CAPACITY (MW)
Silverton Wind Farm	Powering Australian Renewables Fund	NSW	200
Mount Emerald Wind Farm	RATCH	QLD	180
Badgingarra Renewable Facility	APA Group	WA	130
Willogoleche Wind Farm	Engie	SA	119
Bodangora Wind Farm	Infigen Energy	NSW	113
Crowlands Wind Farm	Pacific Hydro	VIC	80
Timboon West Wind Farm	BayWa r.e.	VIC	7.2
Yawong Wind Farm	BayWa r.e.	VIC	7.2



10 largest wind farms active

Project	State	Capacity (MW)	N. Turbine	Operated by
Coopers Gap Wind Farm	QLD	453	123	AGL ENERGY
Macarthur Wind Farm	VIC	420	140	AGL ENERGY
Snowtown Wind Farm	SA	369	137	TILT RENEWABLE
Hallett Wind Farm	SA	351	167	AGL ENERGY
Hornsedale Wind Farm	SA	315	99	NEOEN
Lake Bonney Wind Farm	SA	278	112	INFIGEN ENERGY
Sapphire Wind Farm	NSW	270	75	CWP RENEWABLE
Ararat Wind Farm	VIC	240	75	GENERAL ELECTRIC
Murra Warra Wind Farm	VIC	226	89	RES RENEWABLE
Lincoln Gap Wind Farm	SA	212	59	ERM POWER



Battery Storage

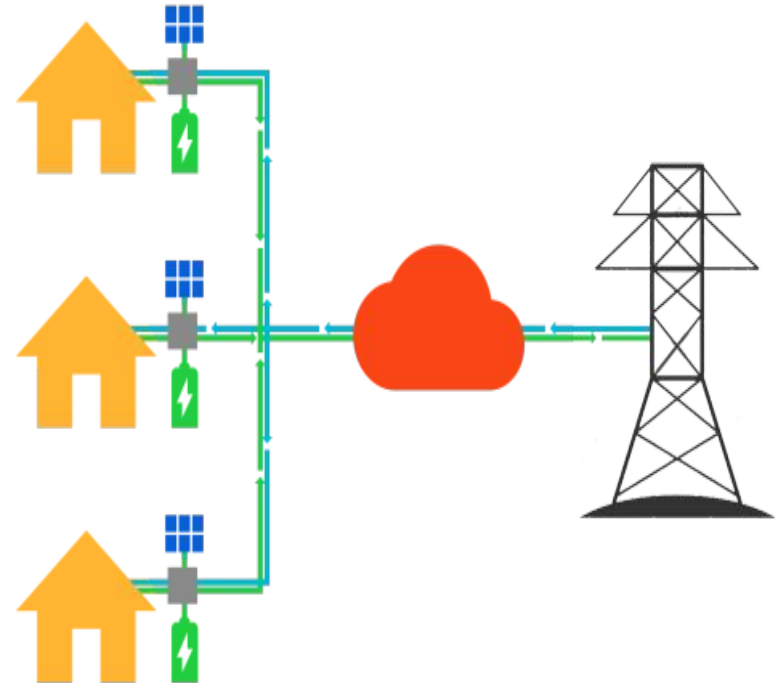
- 22,661 households batteries installed in 2019;
- South Australia's and Victoria Home Battery Scheme;
- The battery installation standard AS/ NZS 5139 was accepted in July 2019;
- Investment in electricity storage will increase to balance supply and demand within the NEM.
- Many renewable generation projects will incorporate battery storage





Virtual Power Plant (VVP)

- The integration of batteries into virtual power plants (VPPs) will play a crucial role in the renewable energy future;
- VPPs involve a network of distributed energy resources, including batteries, buying and selling energy in real-time;
- Two-sided national energy market that will enable consumer participation.





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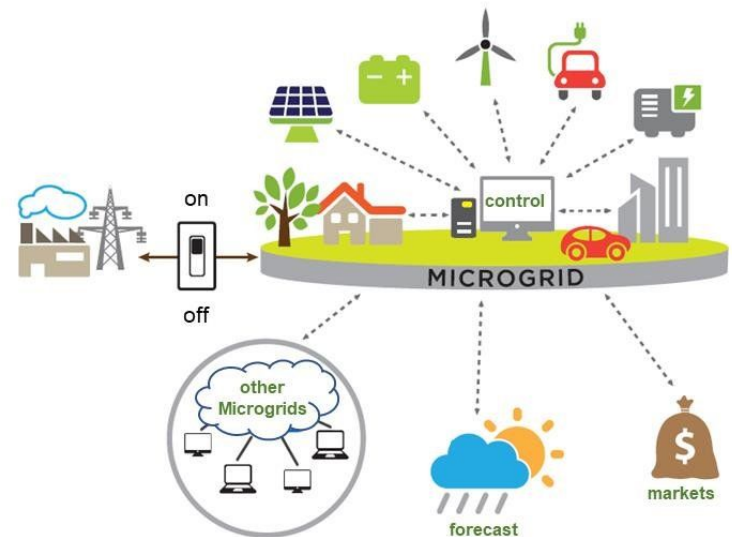
“Batteries” under construction

STATE	PROJECT NAME	PROJECT OWNER	LOCALITY	SIZE OF SYSTEM
QLD	Wandoan South BESS	Vena Energy	Wandoan South	100MW/150MWh
SA	Hornsedale Power Reserve Stage 2	Neoen	Hornsedale	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



Microgrids

- In October 2018, the Victorian Government announced an investment of \$14M in to a 'Microgrid Development Initiative'
- Case study: Mondo 3rd installator (Yackandandah)
 - 33 x houses involved
 - 8 x subsidised batteries
 - 7 x subsidised CO2 hot water heat pumps
 - 12 x additional smart energy devices
 - \$380,000 funding from Vic Govt.
- The role of Electric vehicles





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Hydroelectric

- The drought of 2019;
- Snowy Hydro 2.0
 - (2000 MW/350,000 MWh)
 - Adds 2GW capacity at a cost of between \$3.8 and \$4.5 billion;
 - Salini Impregilo (We build) won the tender;
- Queensland privatisation in October 2019;
- The overall outlook is positive.





Hydro power contribution

YEAR	GENERATION (GWh)	CONTRIBUTION TO RENEWABLES	CONTRIBUTION TO TOTAL ELECTRICITY
2013	19,243	55.4%	8.2%
2014	14,555	45.9%	6.2%
2015	14,046	40.1%	5.9%
2016	17,747	42.3%	7.3%
2017	13,331	34.6%	5.9%
2018	17,002	35.2%	7.5%
2019	14,166	25.7%	6.2%



Hydrogen

- COAG Energy Council launched the National Hydrogen Strategy in 2019 (\$370 million of investments);
- South Australia and Western Australia have both created their own hydrogen strategies;
- Hydrogen is a strategic energy vector both for the Australian internal and export markets





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GAS



- Australia recently overtook Qatar to become the world's largest exporter of liquefied gas [LNG];
- QLD and WA have the main projects;
- Bridging technology to reduce emissions;
- LNG/CNG;
- Port Lincoln – B/H Nova 100% H₂ (solar, NH₃, etc.)





Some key projects

- Browse Upstream Development (WA - Value: \$15 billion Startup year: 2023)
- Browse Basin Satellite Fields (WA- Value: \$10.4 billion Startup year: 2020)
- Surat Gas Project (QLD - Value: \$7.15 billion Startup year: 2020)
- Gorgon LNG Train 4 (WA - Value: \$5.1 billion Startup Year: 2020)





Bioenergy

- Australia's waste recycling policy is behind compared to other countries;
- Very few projects can attract private capitals;
- ARENA is developing a roadmap to identify the role that the bioenergy sector can play;
- Most relevant projects funded:
 - Kwinana Waste to Energy Project. Total cost \$696m
 - East Rockingham Waste to Energy Project. Total cost \$495m





Useful links

- Australian Energy Market Commission (AEMC)
<https://www.aemc.gov.au/>
- Australian Energy Market Operator (AEMO)
<https://aemo.com.au/>
- Australian Renewable Energy Agency (ARENA)
<https://arena.gov.au/>
- Clean Energy Council (CEC)
<https://www.cleanenergycouncil.org.au/>
- Clean Energy Finance Corporation (CEFC)
<https://www.cefc.com.au/>
- Commonwealth Scientific and Industrial Research Organisation (CSIRO) <https://www.csiro.au/>
- All Energy Australia <https://www.all-energy.com.au/>



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Thank you !

