SOLAR REPORT

JANUARY 2020

Australian Energy Council

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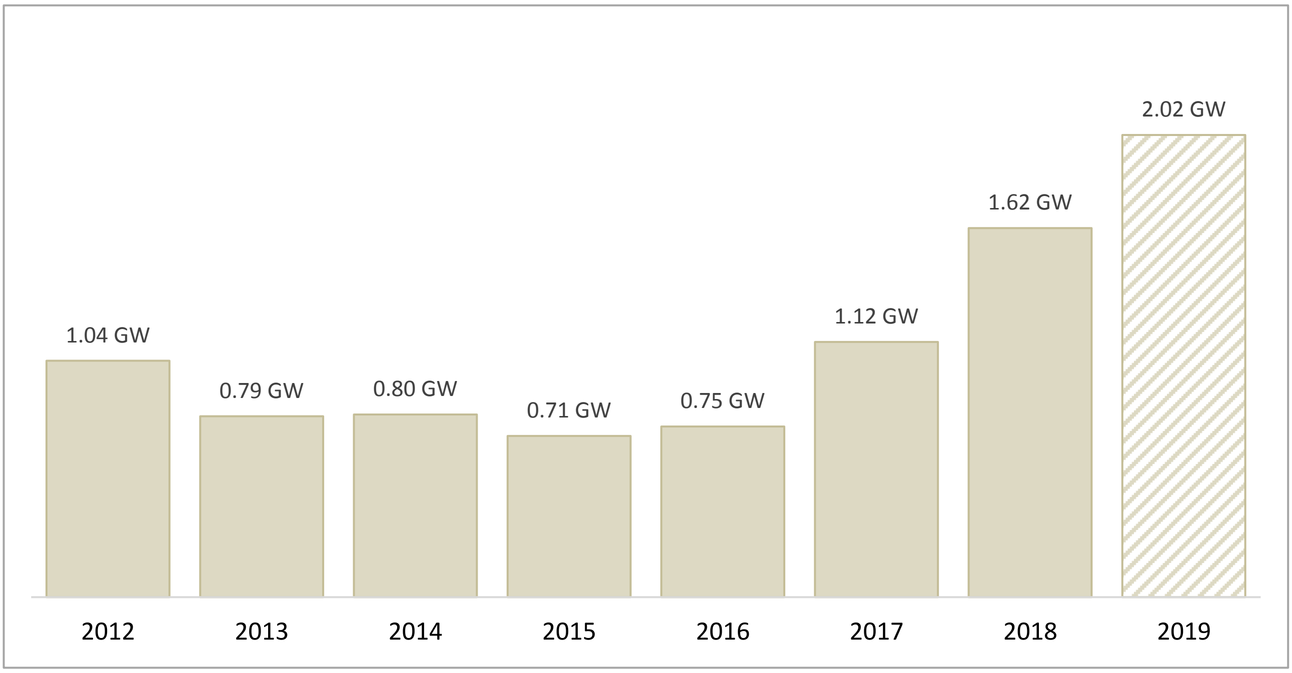
SECTION I: STATE OF SOLAR PV IN AUSTRALIA

Updated data from the Clean Energy Regulator (CER), shows that 2019 was another record-breaking year for solar. Australia remained a strong and growing market for grid-connected solar photovoltaics (PV), with a new record of 2GW of installed rooftop capacity reached by the year-end.

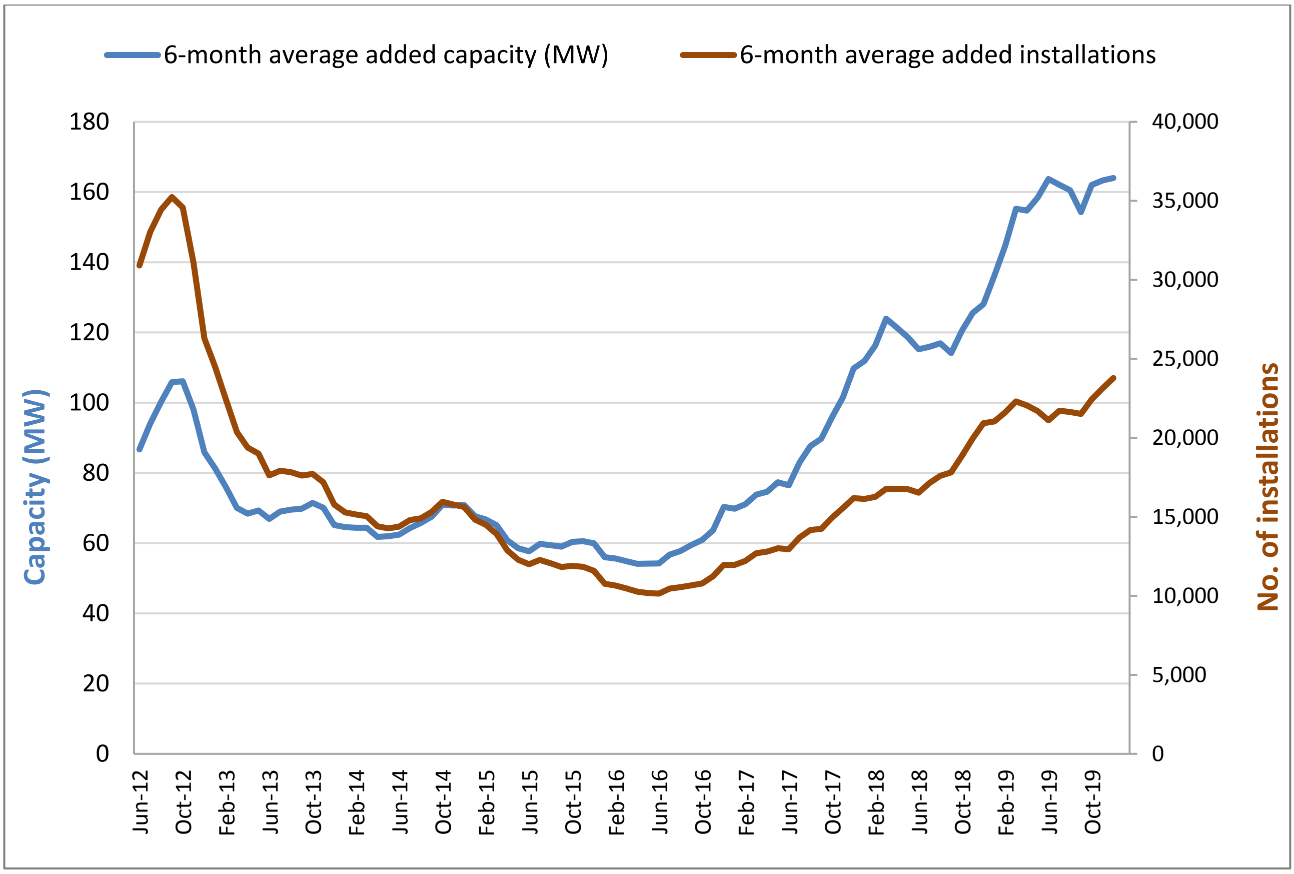
Figure 1 below shows the historical trends in total installed capacity of rooftop PV annually since 2012. Last year saw more than 269,000 rooftop installations added to the grid. By the end of 2019, over 2.3 million Australian homes and businesses had a rooftop PV system.

Figure 1: Total installed capacity (GW) since 2012 in Australia



Source: Clean Energy Regulator data, Australian Energy Council analysis, February 2020

Figure 2: Rolling 6-month installed capacity and number of installations average

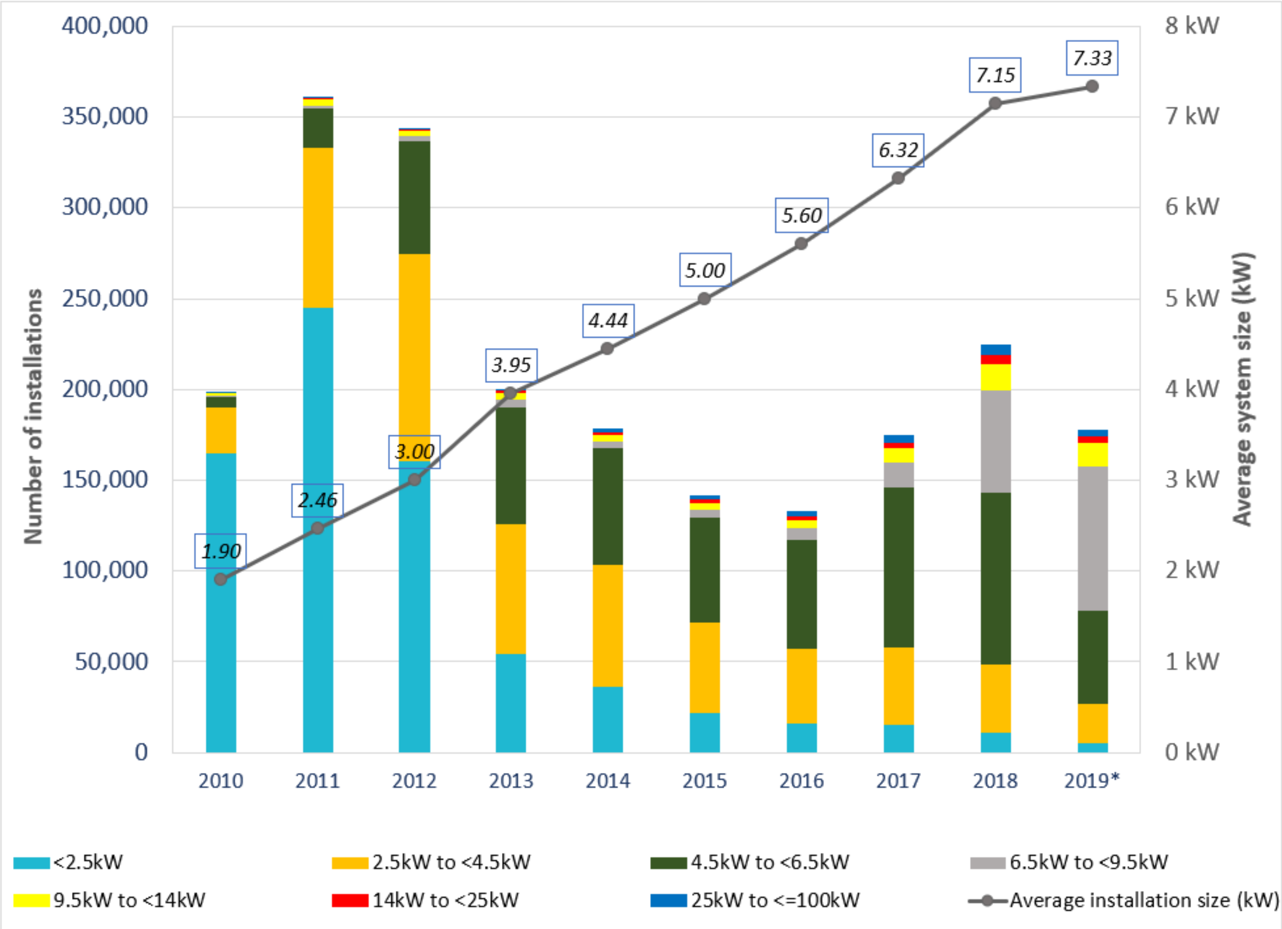


Source: Clean Energy Regulator data, Australian Energy Council analysis, February 2020

Figure 2 again highlights the continued strong growth in Australian rooftop solar installations. The two trend lines continue to widen as bigger solar units are installed, specifically, the rolling average installed capacity (blue line) has been growing at an estimated six-month average rate of 164 MW put on rooftops to December 2019[i], surpassing the old peak of 105.8 MW (set in 2012).

In terms of solar PV system size, Australia's rooftop average system size continues to grow, reaching an average of 7.7kW in 2019, according to the CER's Quarterly Carbon Market Report released this week. As shown in figure 3, since 2015, systems from 4.5kW to 6.5kW were the preferred choice for households up until 2018 (please note figure 3 includes only figures up to Q3 2019 so the data does not fully reflect the full year and hence the maximum average shown is only 7.33kW).

Figure 3: Total small-scale solar installations by size in kW and annual average system size



Source: APVI data, Australian Energy Council analysis.
Note that 2019* includes data from January to September 2019 only.

In 2018, the uptake of bigger systems of between 6.5kW to 9.5kW increased three-fold, when compared to 2017. In 2019, this trend continues with households again choosing to install larger systems of 6.5kW to 9.5kW – and it is now the most common size of solar panel installation, accounting for roughly 45 per cent of total installations in 2019, which is a factor behind the continued increase in the overall average unit size of solar PV systems. The CER[ii] has noted that system sizes of 6.5kW to 7kW continue to dominate the market, balancing economies of scale with ease of network connection; while systems ranging from 7kW to 15kW is a strong growth area in 2019, which the regulator suggests households are finding ways to install systems that are not limited by the usual 5kW limits on exports, such as batteries.

Battery installations with rooftop solar

Shown in figure 4, 2019 also marked a strong year for home battery installations with rooftop solar PV systems. Queensland led the way due to the Queensland Government's scheme introduced in November 2018 under which Queenslanders can apply for interest-free loans of up to $10,000 and grants of $3000 to purchase batteries or combined solar-battery systems[iii]. Approved applicants have six months to install an eligible system.

South Australia overtook New South Wales to rank second last year, accounting for 20.6 per cent of total battery-with-solar installations.

Domestic Battery Developments

Current solar with battery installations has grown from 1,250 at the start of 2016 to over 20,000 at the end of last year, with the CER estimating a cumulative installation of at least 85MW of battery capacity.

As with solar PV installation sizes there is a trend towards larger domestic batteries with the number of batteries with a capacity of more than 10kWh has doubled from 2018 to 2019.

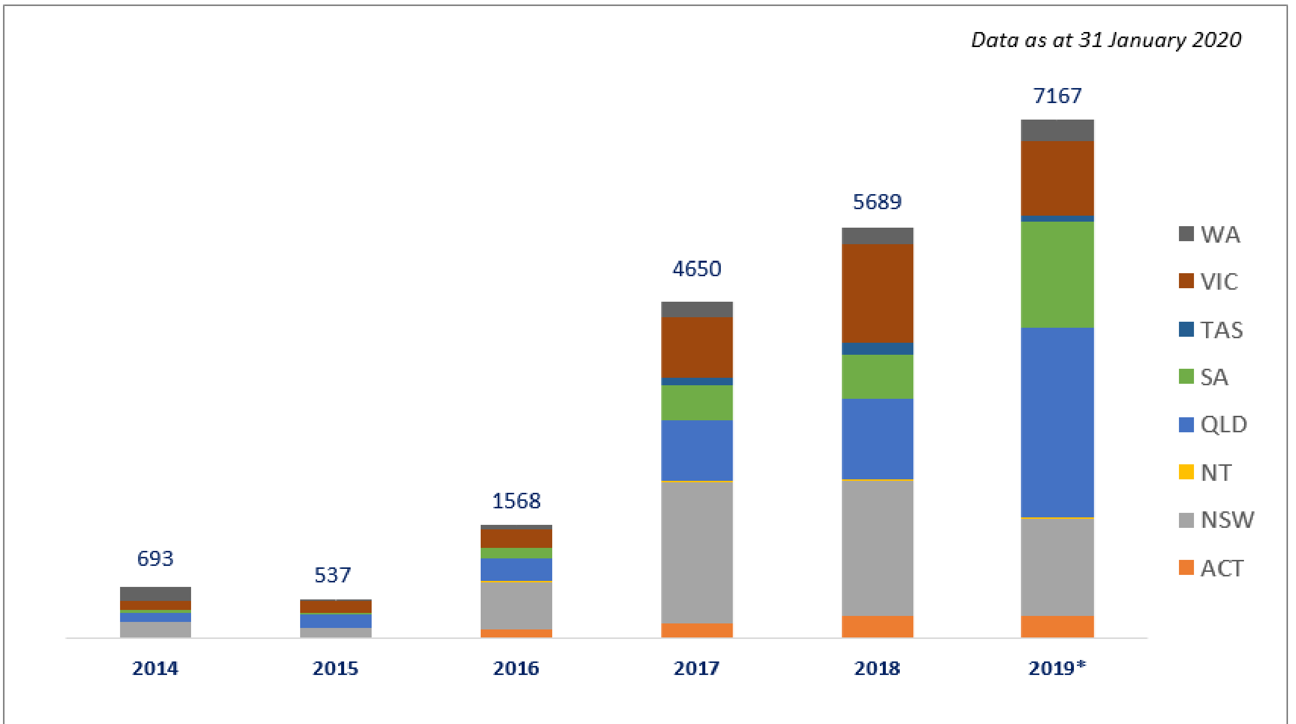
The table below compares the average size of batteries installed for 5-7kW solar PV systems with those for the larger 7-15kW PV systems. For the smaller system sizes there is a consistent trend, while for the bigger PV systems there is an increasing capacity of batteries. That take-up of batteries is undoubtedly being helped along by the state-based schemes. As noted by the CER even though decreasing battery prices may be helping with their adoption the same level of growth has not been seen in states without battery incentive schemes.

Table 1: Average residential battery capacity by solar panel band (kwh/installs)

Year	Solar panels of 5 – 7kW	Solar panels of 7 -15 kW
2018	7.10	7.73
2019	7.63	9.20

Source: Quarterly Carbon Market Report, Clean Energy Regulator, 26th February 2020

Figure 4: Number of solar with concurrent battery installations per state since 2014



** Due to the 12 month creation period, the figures will continue to change (increase)*
***only first three quarters of 2019 data is included*

Source: Clean Energy Regulator data, Australian Energy Council analysis, February 2020

Current state government schemes and rebates for solar panels and solar battery storage also include:

- New South Wales: The Empowering Homes Program which will support installation for up to 300,000 households across the state with zero interest loans to purchase solar and battery systems[iv].
- Victoria: The Solar Homes Program offers up to 1000 rebates of up to $4,838 for a solar-battery system in 2019-20[v].
- South Australia: The Home Battery Scheme offers rebates to around 40,000 households with a grant of up to $6,000 for a home solar battery[vi].

New Victorian minimum feed-in tariff set for 2020-21

A new minimum feed-in tariff (FiT) is set by the Victorian Essential Services Commission (ESC) annually, which requires each electricity retailer to offer at least a single rate or a time-varying FiT. The rates vary from 9.1 to 12.5 cents depending on peak, off peak, single-feed or multiple-feed arrangements and schemes, and will come in effect from 1 July 2020.

The annual changes in the level of the minimum FiT rates are primarily subject to the changes in the future wholesale electricity prices, which have been falling due to the abundance of renewable energy generation.

Table 2: Minimum FiT rates: 2017-18 to 2020-21 (c/kWh)

	2017–18	2018–19	2019–20	2020–21
Single rate minimum FiT	11.3	9.9	12.0	10.2
Time-varying minimum FiT rate				
Peak	n/a	29.0	14.6	12.5
Shoulder	n/a	10.3	11.6	9.8
Off peak	n/a	7.1	9.9	9.1

Source: Minimum feed-in tariff review 2020-21, Essential Services Commission

Currently, the single rate FiTs offered by Victorian retailers range from 12.0 c/kWh (the minimum FiT rate for 2019–20) to 20 c/kWh.

Some retailers offer higher FiT rates when new customers buy a solar package or if existing solar customers switch their electricity accounts. As at February 2020, only EnergyAustralia offers both a single rate FiT and a time-varying FiT rate to Victorian customers. Several other retailers offered contractual arrangements to battery owners, which involve dynamic pricing of electricity exports.

SECTION II: ENERGY CURTAILMENT

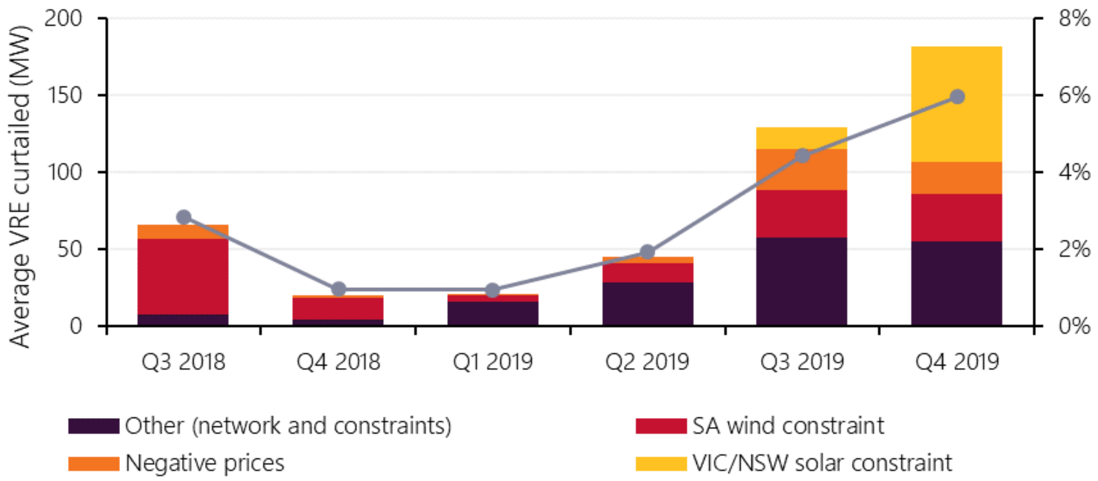
Solar and wind curtailment in Australia

The Australian Energy Market Operator's (AEMO) latest Quarterly Energy Dynamics report shows the curtailment of Australia's solar and wind generation in the National Energy Market (NEM) reached the highest amount on record in the final quarter of 2019.

Wind and solar generation curtailment increased to 6 per cent of total renewable energy output. The report highlights the main cause is the high system security constraint on five solar farms: New South Wales's Broken Hill solar farm and Victoria's Bannerton, Gannawarra, Karadoc and Wemen solar farms.

Figure 5 shows different causes leading to curtailment. Network and constraints remain a relatively large factor with AEMO estimating an average of 55 MW in the fourth quarter of 2019. The main factor in Q4 2019 however was the solar constraint in New South Wales and Victoria, which increased from 14 MW to 75 MW with the output cut for the entire quarter, compared to less than one month in the third quarter of 2019.

Figure 5: Victoria and New South Wales solar constraint drives increasing VRE curtailment



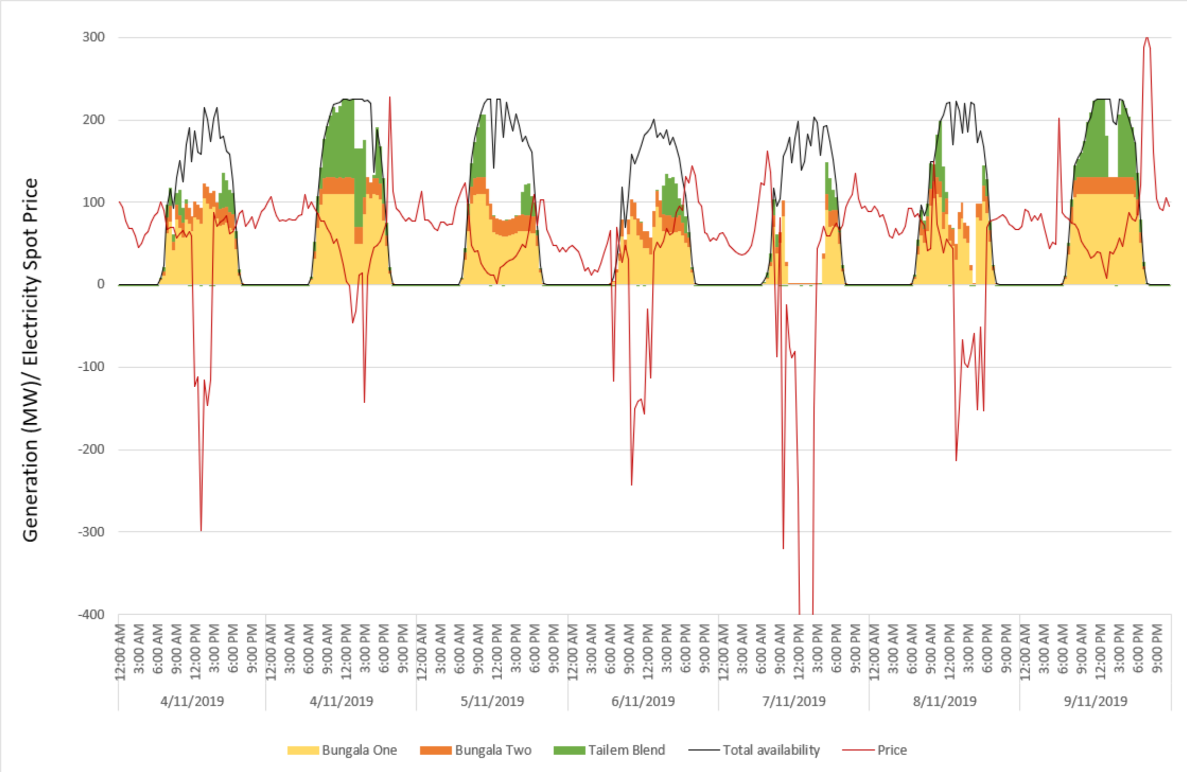
Source: AEMO's Quarterly Energy Dynamics Q4 2019

How curtailment is occurring

Curtailment occurs when less output from wind and solar farms than is actually available is put into the grid. AEMO notes that contributors to this curtailment includes: Self-curtailment by operators in response to negative prices, system security constraints, such as those referred to above with the five solar farms, system strength constraints in South Australia and transmission outages and other network constraints, as well as excess generation.

AEMO's report highlights that negative prices contributed to an average of 21MW of curtailment in South Australia. In the chart below, the many white gaps indicate where curtailment occurred with the black line showing the amount of available solar generation that was not generated. This happens in response to negative spot price events (red line). Particularly on 7 November, three solar farms were switched off completely as prices were reaching the floor price of -$1,000/MWh. This is a clear example of voluntary curtailment by the generator.

Figure 6: Solar farms generation in South Australia and electricity spot price



Source: Australian Energy Council's analysis on NEO Express data

Over provisioning of solar and wind drives the price down during the day, yet it is important to continue curtailing the generation proactively. Energy storage can play a role by storing the excess power that is curtailed and not fed into the grid. This resource then can be used to meet the demand when the sun does not shine, or wind does not blow. South Australia now has three batteries: Hornsdale, Dalrymple North and Lake Bonney. These batteries are still relatively small and mostly are on standby for emergency response or to provide frequency and ancillary services market.

There is potential for the grid to be firmed up through a combination of overprovisioning and storage, which would allow more variable renewable energy resources to be effectively dispatchable.

SECTION III: LEVELISED COST OF ENERGY

The Levelised Cost of Energy (LCOE) is the cost of energy per kWh produced. When this is equal to or below the cost consumers pay directly to suppliers for electricity, this is called grid parity. Table 2 shows the LCOE for solar in Australia's major cities, indicative retail prices and current FiT rates. The detailed methodology can be found in the Appendix.

The retail comparison rates are representative variable rates and do not include supply charges. For all capital cities, excluding Perth and Hobart, retail prices are based on the implied usage charges from St Vincent de Paul's tracking of market offers, which was last updated in July 2019. Perth prices are regulated and obtained from Synergy. Hobart prices were obtained from Aurora Energy's Tariff 31, while Darwin prices are obtained from Jacana Energy's regulated residential usage charges. Tables 3, 4 and 5 show the LCOE across major cities at different discount rates.

Table 3: Central estimate: 6.07 per cent discount rate (ten-year average mortgage rate)

All figures in $/KWh	System Size							Retail prices	FIT
	1.5 kW	3 kW	4 kW	5 kW	6 kW	7 kW	10 kW		
Adelaide	$0.18	$0.13	$0.11	$0.11	$0.10	$0.10	$0.10	$0.42	$0.15
Brisbane	$0.16	$0.12	$0.11	$0.11	$0.10	$0.10	$0.11	$0.28	$0.15
Canberra	$0.15	$0.11	$0.11	$0.10	$0.09	$0.10	$0.09	$0.24	$0.11
Darwin	$0.27	$0.17	$0.15	$0.15	$0.13	$0.13	$0.10	$0.26	$0.24
Hobart	$0.21	$0.15	$0.14	$0.14	$0.14	$0.14	$0.13	$0.27	$0.09
Melbourne	$0.21	$0.14	$0.13	$0.12	$0.11	$0.12	$0.12	$0.28	$0.15
Sydney	$0.18	$0.12	$0.11	$0.10	$0.10	$0.11	$0.10	$0.29	$0.15
Perth	$0.14	$0.09	$0.09	$0.08	$0.08	$0.09	$0.09	$0.29	$0.07

Source: Australian Energy Council analysis, February 2020

Table 4: Low cost of capital sensitivity: 4.17 per cent discount rate (low current standard variable rate)

All figures in $/KWh	System Size							Retail prices	FIT
	1.5 kW	3 kW	4 kW	5 kW	6 kW	7 kW	10 kW		
Adelaide	$0.16	$0.12	$0.11	$0.10	$0.10	$0.10	$0.10	$0.42	$0.15
Brisbane	$0.15	$0.11	$0.10	$0.10	$0.09	$0.10	$0.10	$0.28	$0.15
Canberra	$0.14	$0.10	$0.10	$0.09	$0.08	$0.09	$0.09	$0.24	$0.11
Darwin	$0.24	$0.16	$0.14	$0.13	$0.12	$0.12	$0.10	$0.26	$0.24
Hobart	$0.19	$0.14	$0.13	$0.13	$0.13	$0.13	$0.12	$0.27	$0.09
Melbourne	$0.19	$0.13	$0.12	$0.11	$0.10	$0.11	$0.11	$0.28	$0.15
Sydney	$0.17	$0.11	$0.10	$0.10	$0.09	$0.10	$0.10	$0.29	$0.15
Perth	$0.12	$0.09	$0.08	$0.07	$0.07	$0.08	$0.09	$0.29	$0.07

Source: Australian Energy Council analysis, February 2020

Table 5: High cost of capital sensitivity: 13.56 per cent discount rate (indicative personal loan rate)

All figures in $/KWh	System Size							Retail prices	FIT
	1.5 kW	3 kW	4 kW	5 kW	6 kW	7 kW	10 kW		
Adelaide	$0.25	$0.18	$0.15	$0.14	$0.14	$0.14	$0.14	$0.42	$0.15
Brisbane	$0.23	$0.16	$0.15	$0.14	$0.13	$0.14	$0.14	$0.28	$0.15
Canberra	$0.21	$0.14	$0.14	$0.13	$0.12	$0.13	$0.12	$0.24	$0.11
Darwin	$0.39	$0.24	$0.21	$0.20	$0.18	$0.17	$0.14	$0.26	$0.24
Hobart	$0.29	$0.21	$0.19	$0.19	$0.19	$0.18	$0.17	$0.27	$0.09
Melbourne	$0.29	$0.19	$0.17	$0.15	$0.14	$0.16	$0.16	$0.28	$0.15
Sydney	$0.25	$0.16	$0.15	$0.13	$0.13	$0.14	$0.13	$0.29	$0.15
Perth	$0.19	$0.12	$0.11	$0.10	$0.10	$0.11	$0.12	$0.29	$0.07

Source: Australian Energy Council analysis, February 2020

Small and Large business - Levelised Cost of Electricity

Tables 6 and 7 show the estimated cost of electricity production for commercial-sized solar systems. As businesses look to reduce overhead costs, installation of large-scale solar panels continue to increase.

Business tariffs differ to residential retail tariffs. Depending on the size of the customer and the amount of energy used, businesses have the ability to negotiate lower prices. If a business was to consume all electricity onsite, the electricity prices in Tables 6 and 7 would represent the cost per kWh of consumption from the energy generated from the different system sizes listed. For businesses, installation occurs if the benefits of installation outweigh the cost. The average electricity bill for industrial businesses in 2014-15 was 10.72 c/kWh[vii.]

The CER sets out guidelines for the redemption of small-scale certificates. There are two criteria which can exclude a system from receiving STCs: Systems cannot exceed 100 kW in capacity or generate more than 250 MWh per year[viii.]

Table 6: Central estimate: 6.79 per cent discount rate, ten-year average small business interest rate

All figures in $/KWh	System Size				
	10kW	30kW	50kW	70kW	100kW
Adelaide	$0.12	$0.11	$0.11	$0.11	$0.10
Brisbane	$0.12	$0.11	$0.12	$0.11	$0.10
Canberra	$0.11	$0.10	$0.11	$0.11	$0.10
Hobart	$0.17	$0.15	$0.15	$0.15	$0.13
Melbourne	$0.14	$0.13	$0.14	$0.13	$0.12
Sydney	$0.13	$0.12	$0.12	$0.12	$0.11
Perth	$0.13	$0.11	$0.12	$0.11	$0.10

Source: Australian Energy Council analysis, February 2020

Table 7: Central estimate: 4.73 per cent discount rate, ten-year average large business interest rate

All figures in $/KWh	System Size				
	10kW	30kW	50kW	70kW	100kW
Adelaide	$0.11	$0.11	$0.10	$0.10	$0.10
Brisbane	$0.11	$0.10	$0.11	$0.11	$0.10
Canberra	$0.10	$0.09	$0.10	$0.10	$0.09
Hobart	$0.15	$0.14	$0.14	$0.13	$0.12
Melbourne	$0.13	$0.12	$0.13	$0.12	$0.11
Sydney	$0.12	$0.11	$0.11	$0.11	$0.10
Perth	$0.12	$0.10	$0.11	$0.10	$0.09

Source: Australian Energy Council analysis, February 2020

SECTION IV: PAYBACK PERIOD, DETAILED MODEL

Using a similar methodology to that used to calculate the LCOE of solar PV in Australia (see Section 4), the Australian Energy Council has calculated the payback period for residential solar PV systems.

The payback period is defined as the year when the cumulative savings are greater than the cumulative costs of a solar PV system. Savings represent the avoided cost of consumption and any revenue received from FiTs. The cumulative cost incurred represents the initial investment and the time value of money. A detailed methodology is contained in Appendix 2.

Figure 8 highlights the payback period for different system sizes across Australia. Note that electricity prices are subject to change with CPI levels (currently 1.8 per cent, last updated February 2020) and thus will affect the payback period. Many retailers offer higher solar FiTs, which help to offset the impact of higher prices in some states and deliver savings to customers with solar panels. The low payback periods across many cities further highlights the greater encouragement for customers to install solar PV.

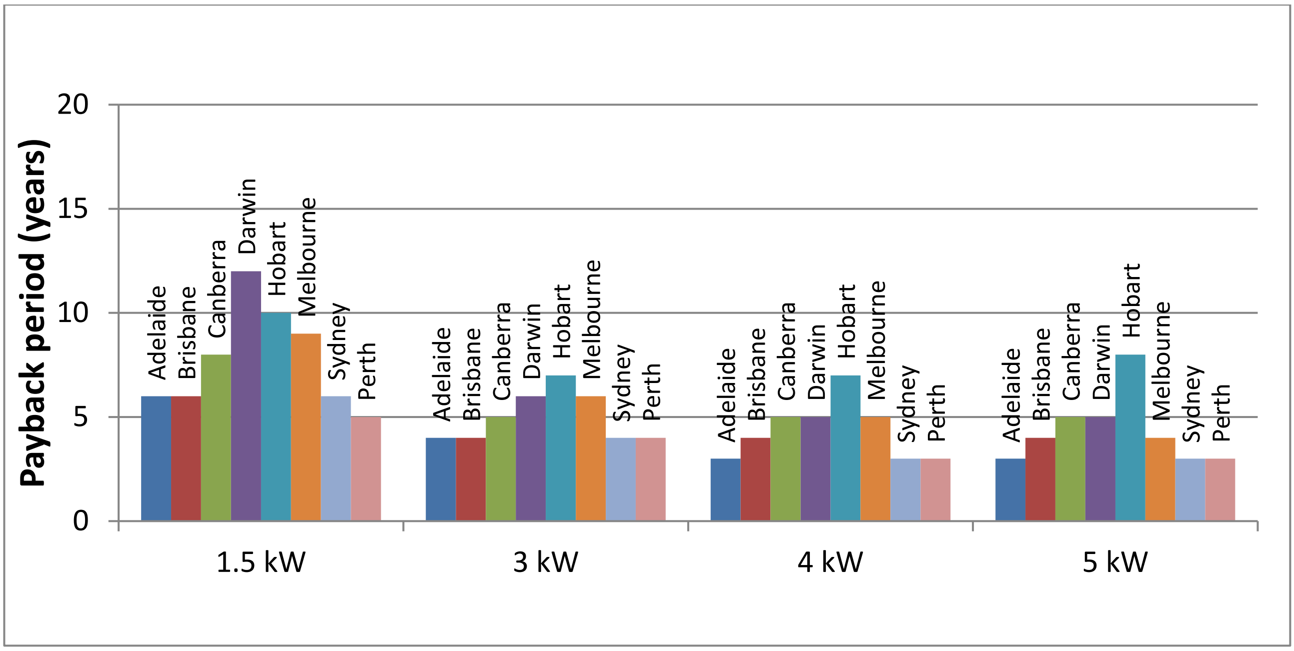
Figure 7: Payback period for solar PV (4.17 per cent discount rate)

Source: Australian Energy Council analysis, February 2020

In 2018, Darwin had the highest FiTs with a minimum of 25.7c/kWh, yet it also had a high payback period (16 years for a 2kW system or 13 years for a 3kW system at 5.30 per cent discount rate). As of February 2020, even though Darwin's FiTs have been lowered to a minimum 23.6c/kWh, the city no longer has the highest payback period, being overtaken by Hobart.

Figure 8 shows the expected payback period for systems with a 6.07 per cent discount rate (10-year average home loan rate).

Figure 8: Payback period for solar PV (6.07 per cent discount rate)



Source: Australian Energy Council analysis, February 2020

As many residential customers are now considering a larger PV system size, the trends in both figures 7 and 8 show the bigger the system, the lower the number of years a customer will have to pay back the loan for installation.

SECTION V: METHODOLOGY APPENDIX

1. Solar installations methodology

Analysis from the Clean Energy Regulator's (CER) monthly data allows us to estimate the amount of solar PV installed in Australia. Since November 2015, the CER has consistently released data dated as at the first of each month. The new consistent release date allows us to provide a more accurate estimate of the capacity of recent installations. Due to the lag in reporting of new installations, however, the CER data takes up to 12 months to be finalised.

2. Levelised Cost of Electricity Methodology

Introduction

The methodology outlines our approach in calculating the Levelised Cost of Electricity (LCOE) for solar panels installed across capital cities in Australia. Our analysis includes the following:

- Initial investment
- Annual costs
- Discount rate
- Efficiency
- System degradation rate

Initial investment

The initial investment plays a major role in the LCOE calculations. The initial investment represents the cost of buying and installing solar panels all values are inclusive of Federal small-scale technology certificate (STC) discounts.

The initial investments in this report are obtained from the Solar Choice website. Solar Choice takes prices from over 125 installers across Australia and updates pricing data monthly.

Annual costs

We have estimated the annual cost to clean a solar panel at $12.50[ix], and the average sized solar panel in our calculations to be 200W.

Discount rate

The discount rate represents the risk nature of the consumer. For this exercise, three different discount rates have been used and will be updated each quarter. The central estimate is based on the 10-year average home loan, as presented by the Reserve Bank of Australia (6.07 per cent).

The low discount rate sensitivity is based on the minimum variable home loan mortgage rate offered by the Big Four banks (currently 4.17 per cent).

The high discount rate sensitivity is based on personal loans offered by the Big Four banks as the assumption has been made that a personal loan will include all costs including the initial start-up of the loan (13.56 per cent).

Small business and large business discount rates are based on the 10-year average of the variable weighted average rate on credit outstanding. The large business discount rate is 6.79 per cent and the small business discount rate is 4.73 per cent.

The discount rate also takes into account the Consumer Price Index (CPI); this has been given a constant value of 1.8 per cent.

Efficiency

The kWh/kWp represents the average daily production of solar panels. The number was obtained from the Clean Energy Council's consumer guide to installing household solar panels[x]. The efficiency figure represents the average daily output for a 1 kW system.

System degradation rate

The system degradation rate is used to show the reduced output of a system from year to year. Numbers vary from approximately 0.1 per cent to 1 per cent depending on the system. The Australian Energy Council has used 0.5 per cent as a constant degradation rate for all LCOE calculations.

Formula

$$LCOE\ \$/kWh = \frac{Initial\ Investment + \sum_{N=1}^{N} \frac{Annual\ Costs}{(1+Discount\ Rate)^n}}{\sum_{N=1}^{N} \frac{Initial \frac{kWh}{kWp} * (1-System\ Degradation\ Rate)^n}{(1+Discount\ Rate)^n}}$$

Retail comparison rates

St Vincent de Paul tracks market offers on a bi-annual basis. New South Wales, Queensland, South Australia and Victoria implied usage charge of electricity have been obtained from these reports.

A single rate tariff was analysed to calculate the implied usage charge in Victoria, South Australia, New South Wales and the ACT. Tariff 11 in Queensland. Tasmania's usage charge was obtained for Aurora Energy tariff 31 and Synergy the sole retailer in Western Australia was used.

3. Payback period methodology

This methodology outlines our approach in calculating the payback period for solar panels installed across capital cities in Australia. Our analysis includes the following:

- Initial investment
- Discount rate
- Efficiency
- System degradation rate
- Export rate
- Avoided usage cost
- FiT

Initial investment, discount rate, efficiency and system degradation rate are described in appendix 1. Key difference to LCOE calculation is the payback period assumes no annual maintenance cost.

Calculation

Payback period occurs when ∑ savings > ∑ cost

Where:

Savings = (usage cost x $(1+ \text{CPI})^t$ x consumption / 100) + (Export x FiT)

Cost = investment x $(1 + \text{real discount rate})^t$

t = years

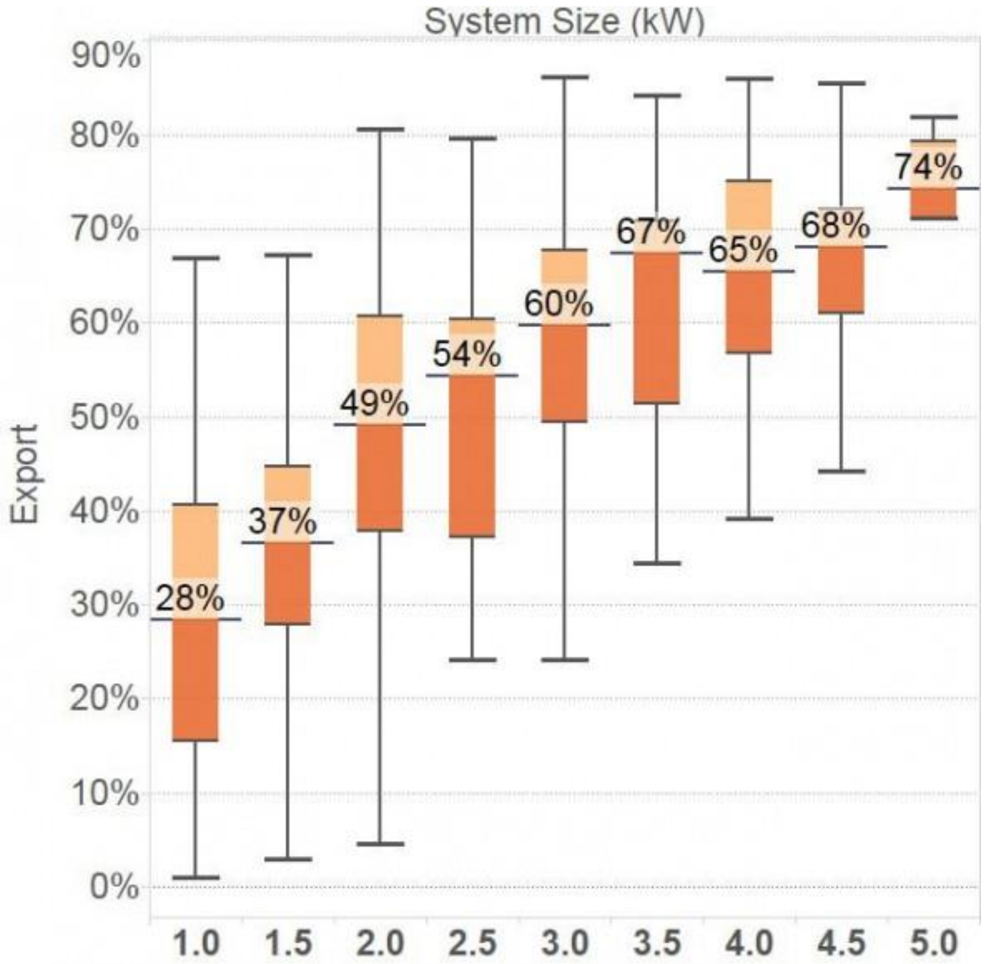
Avoided cost and FiT

The onsite consumption is multiplied by the retailer's usage charges, CPI has been applied to the usage charge to allow for growth in retail prices. The excess energy is exported to the grid and the customer is expected to receive the mandatory FiT or a realistic market offer where mandatory tariffs are not applicable.

Export rate

The percentage of onsite consumption and electricity which is exported to the grid is calculated using the median value from Sunwiz's analysis[xi]. See Figure 10 below.

Figure 10: Export rate of residential solar PV at different system sizes



Source: Sunwiz analysis, 2015

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[i] This is based on estimations of capacity, allowing for the lag in reported data
[ii] Quarterly Carbon Market Report, Clean Energy Regulator, Dec Quarter 2019
[iii] https://www.qld.gov.au/community/cost-of-living-support/concessions/energy-concessions/solar-battery-rebate/about-the-program
[iv] https://energy.nsw.gov.au/renewables/clean-energy-initiatives/empowering-homes
[v] https://www.solar.vic.gov.au/solar-battery-rebate
[vi] https://www.sa.gov.au/topics/energy-and-environment/energy-efficient-home-design/solar-photovoltaic-systems
[vii] BCA, "Impact of Green Energy Policies on Electricity Prices", June 2014
[viii] Clean Energy Regulator, "How to have STCs assigned to you as a Registered Agent", http://ret.cleanenergyregulator.gov.au/For-Industry/Agents/Having-STCs-assigned-to-you/stcs-assigned-to-you
[ix] estimate based on, RenewEconomy, 26 August 2013, http://reneweconomy.com.au/2013/hidden-cost-of-rooftop-solar-who-should-pay-for-maintenance-99200
[x] Clean Energy Council, http://www.solaraccreditation.com.au/dam/cec-solar-accreditation-shared/guides/Guide-to-installing-solar-PV-for-households.pdf
[xi] Sunwiz, Solar Pays Its Way on Networks. Last accessed 17 June 2015.