SOLAR REPORT

SEPTEMBER 2017

Australian Energy Council

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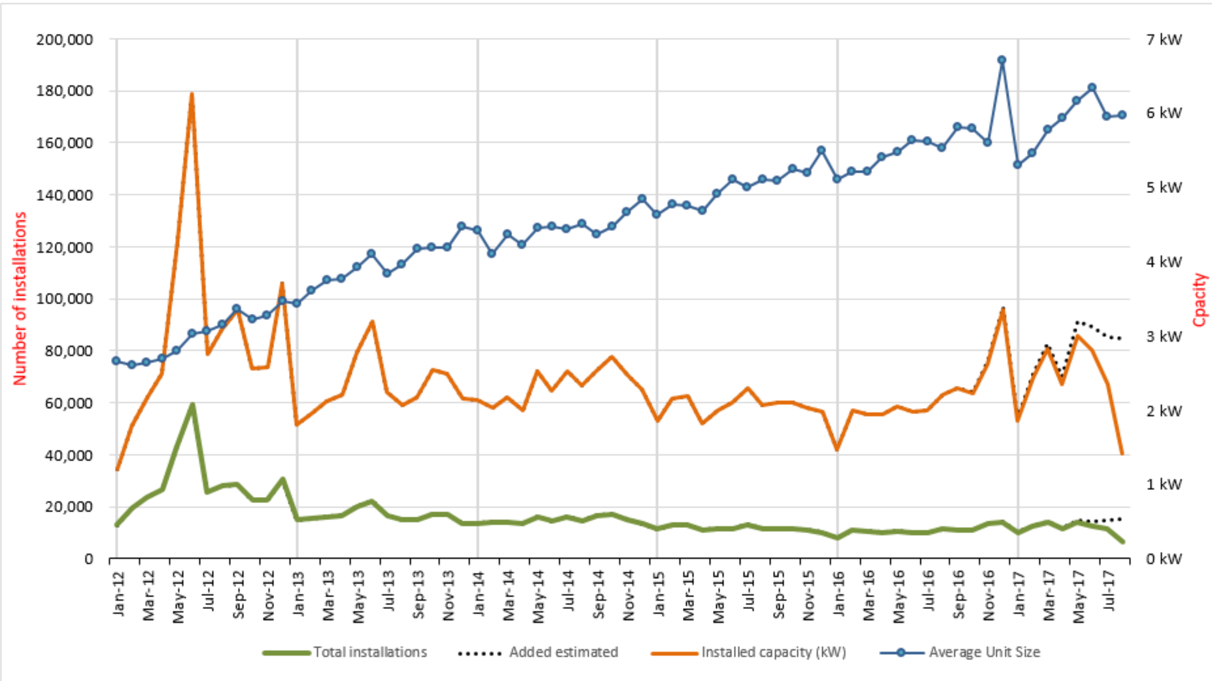
SECTION I: STATE OF SOLAR PV IN AUSTRALIA

By the end of August 2017, cumulative installed capacity for solar PV in Australia stood at 6,005 MW with more than 1.73 million installations. This is up from a previous record of 5,161 MW and 1.59 million installations at the same time last year, illustrating the continued strong growth in solar installations. While the trend for installed solar photovoltaic (PV) system installations since January 2017 has fluctuated, the monthly average unit size is growing strongly and reached 5.78 kW in March 2017. By June the unit sizes were estimated to have reached 6.33 kW. The two most recent months of July and August show a sharp drop due to the 12-month lag in data[1], which does not reflect the actual capacity uptake as of 1 September 2017.

Figure 1 shows the monthly data for solar PV installations since 2012. It is surprising to see that although the monthly number of installations has been consistent for the past two years, the monthly average unit size is rising at the fastest rate we have yet observed. This was also highlighted in our March Solar Report, which showed customers were opting for bigger system sizes with one factor being the rapid fall in solar PV costs.

With the deployment of new battery storage technologies, the growth of rooftop PV is expected to be driven more in future by the commercial and industrial sectors rather than residential installers, who have been the main source of growth up to this point.

Figure 1: Monthly installations, installed solar PV capacity and average system size Jan 2012 – 2017

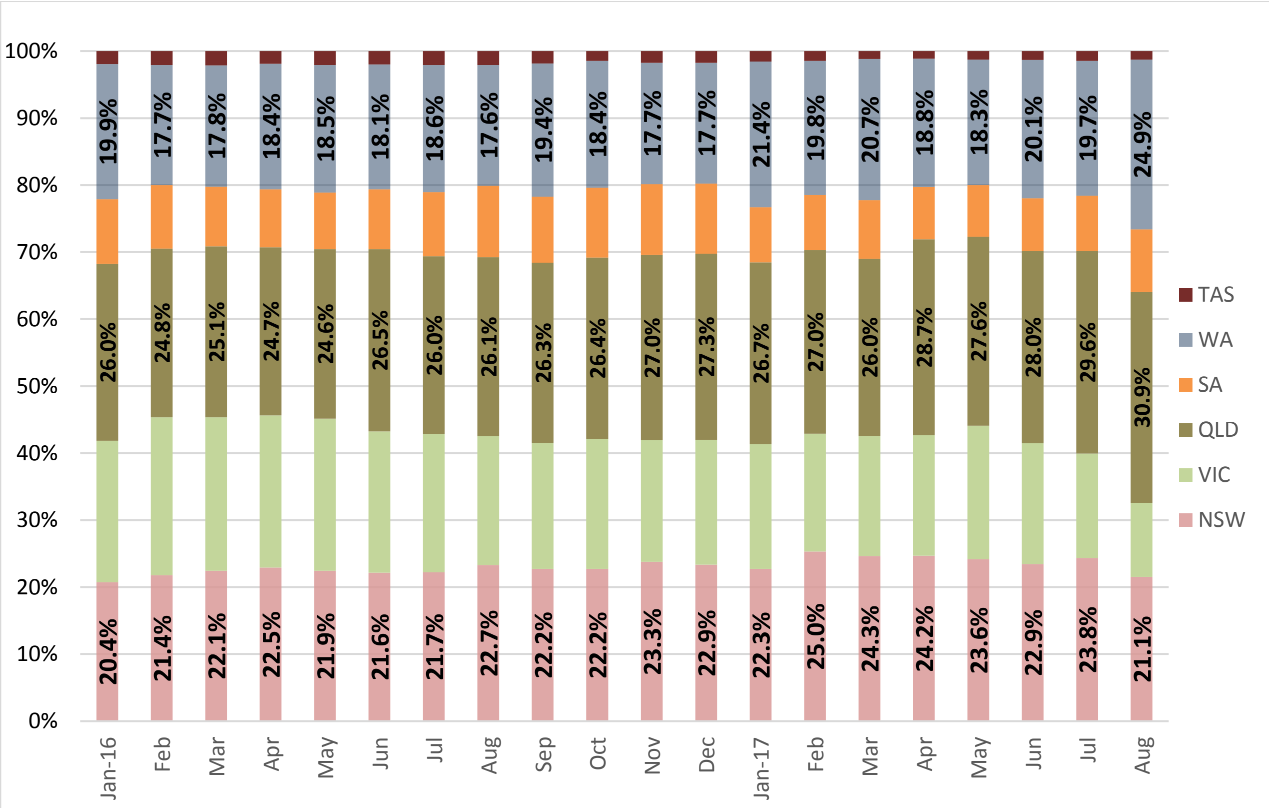


Source: Clean Energy Regulator (adjusted data), Energy Council's analysis, September 2017

The latest data updated by the Clean Energy Regulator last week shows that January continues to be the lowest month for solar PV installations. It is worth noting that due to the 12-month reporting lag[1] for solar systems, the raw January 2017 month data only accounts for an estimated of 98.4 per cent of the total installations. An estimated 10,200 systems were installed in January 2017, which is 20 per cent higher than the previous January (8,205 installations).

At a breakdown level, Figure 2 shows the proportion of each month's number of solar PV installations by state from January 2016 to August 2017. Solar installation growth rates have slowed in New South Wales and Victoria in recent months. Victoria had a significant drop in solar uptake, accounting for only 10.8 per cent of total installations in August, compared to 15.2 per cent in the previous month. In contrast, Western Australia and Queensland have shown an increasing trend in solar PV installations and for the first time Western Australia recorded almost a quarter of all Australian PV installations.

Figure 2: Proportion of monthly solar PV installation numbers by state



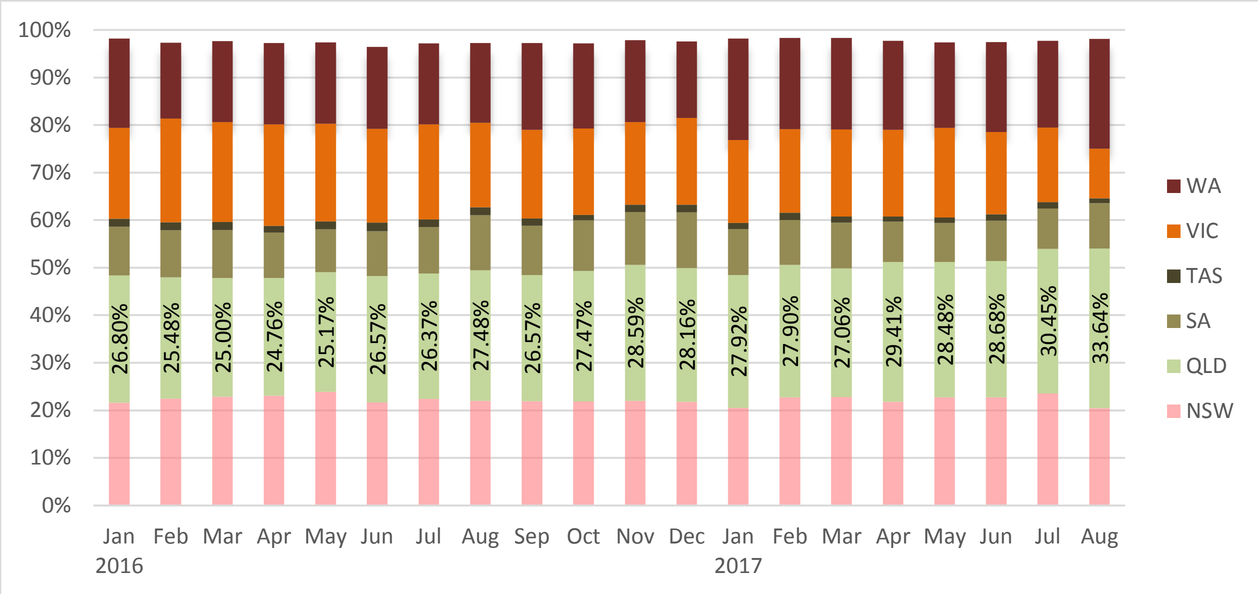
Source: Clean Energy Regulator (adjusted data), Energy Council's analysis, September 2017

Queensland's monthly installed capacity remains the largest and has grown strongly over the past few months. That state alone reached slightly over a third of total installed solar capacity in August,

[1] Solar PV system owners have up to 12 months to report their data to the Clean Energy Regulator, so the reported data for the most recent months is likely to understate the number of actual installations, as well as the installed capacity.

it previously accounted for more than a third of all installations nationally in July 2014 (34.45 per cent). The trend of an increasing uptake of rooftop PV is expected to continue.

Figure 3: Proportion of monthly installed solar PV capacity by state



Note: The Northern Territory and the ACT have been excluded, due to their small population size.

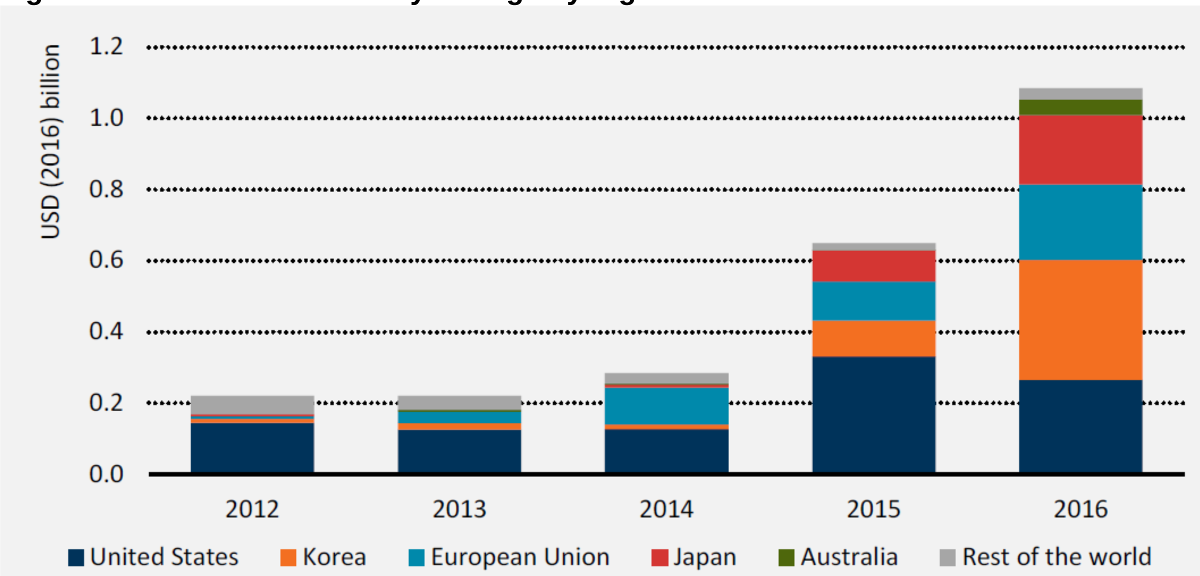
Source: Clean Energy Regulator (adjusted data), Energy Council's analysis, September 2017

SECTION II: BATTERY STORAGE UPDATES

In June 2017, Australia's Chief Scientist Alan Finkel's plan for the future of the National Electricity Market recommended a bigger focus on energy storage. Grid-scale storage is considered to be a potential source for reliability and flexibility. Batteries continue to receive significant attention due to their modularity as well as recent ongoing development of the technology. The battery market is of significant interest both locally and internationally and is expected to be the next major consumer-driven deployment of energy technology. The recently released International Energy Agency's World Energy Investment 2017 provides some insight into the latest battery investments.

According to the IEA, investment in battery storage is ramping up quickly around the world due to a fall in the price of the technology and reached over US$1 billion in 2016. That is at least 40 per cent higher than 2015. To give it some context, it still remains relatively small compared to other forms of network investment, accounting for an equivalent of 0.4 per cent of total network investments. Regardless, a record of over 570 MW of battery storage was commissioned last year and the IEA report expected another 610 MW to be operating in the first half of 2017 around the world. Figure 4 shows the spending on battery storage by region.

Figure 4: Investment in battery storage by region



Source: World Energy Investment 2017, IEA, page 51

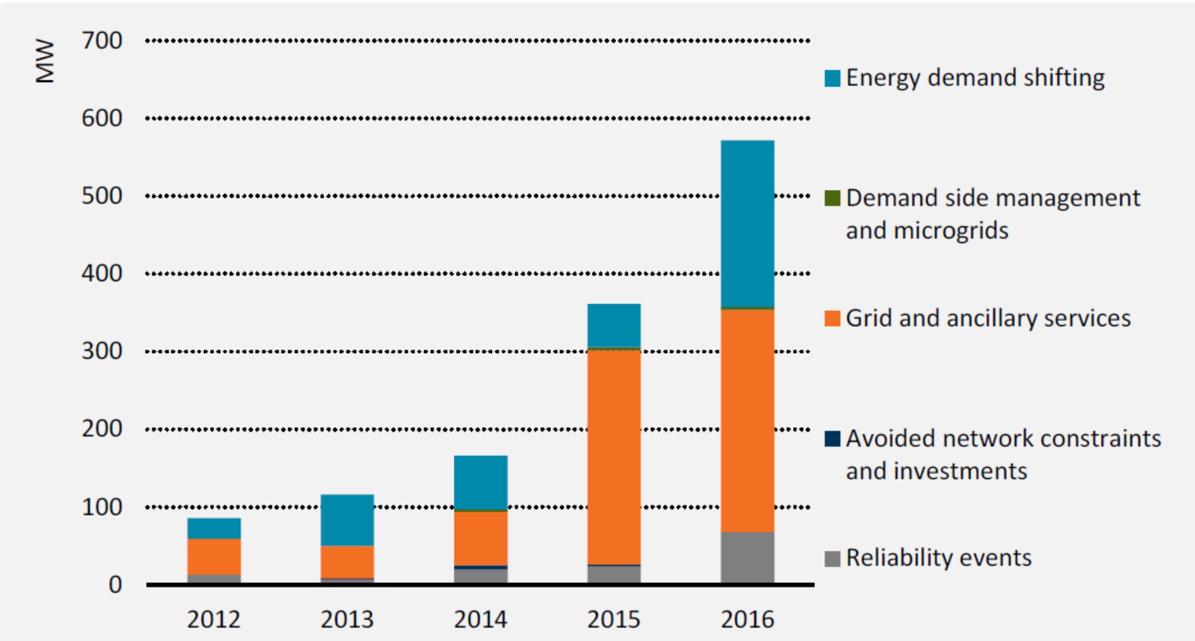
South Korea took over first place from the US. Korea's investment in battery storage in 2016 reached US$270million, which is four times the investment in 2015. In the United States, policy drivers in different states are encouraging more focus on battery developments than two years ago. California commissioned 70 MW in 2016 and that state is forecast to continue leading the way and has set a target of installing1.8 GW of storage capacity by 2020.

The Australian battery market is still a highly opaque market, according to Sunwiz[i]. In Australia, with the exiting of ageing coal-fired power stations, it is not surprising to see a surge in battery investment, which reached an estimated US$50 million in 2016, according to the IEA. The battery market size was reported as 6,750 installations totalling 52 MWh in 2016, dominated by the two largest markets in New South Wales and Queensland[ii]. There has been an increase in grid-scale installations mostly associated with large-scale solar PV plants and 10 MW was installed in 2016 with plans for at least 100 MW more announced in July 2017[iii]. Subsequent to the IEA report, South Australia, in response to tightening local supply, has committed to build the world's largest lithium-ion battery (100MW) alongside with the third stage of the Hornsdale wind farm. Victoria has also committed to installing major grid-scale battery systems. Bloomberg New Energy Finance forecasts that by 2020, around

100,000 battery storage systems to support rooftop solar photovoltaic generation will be installed, and by 2030, the number of storage systems in Australia could reach one million[iv].

According to the IEA, on average the cost per MW of storage has fallen by 19 per cent per year over the last five years and there is expected to be another fall of almost a third by 2020. While chemical battery costs have fallen steeply, costs have proven to be an obstacle to installation in the past and that may continue to be the case for residential customers. Bloomberg expects that due to the high upfront costs for solar PV with storage, the average payback period for residential customers will only fall to less than 10 years in the early 2020s[v].

Figure 5: Main applications of world battery storage investment



Source: World Energy Investment 2017, IEA, page 118

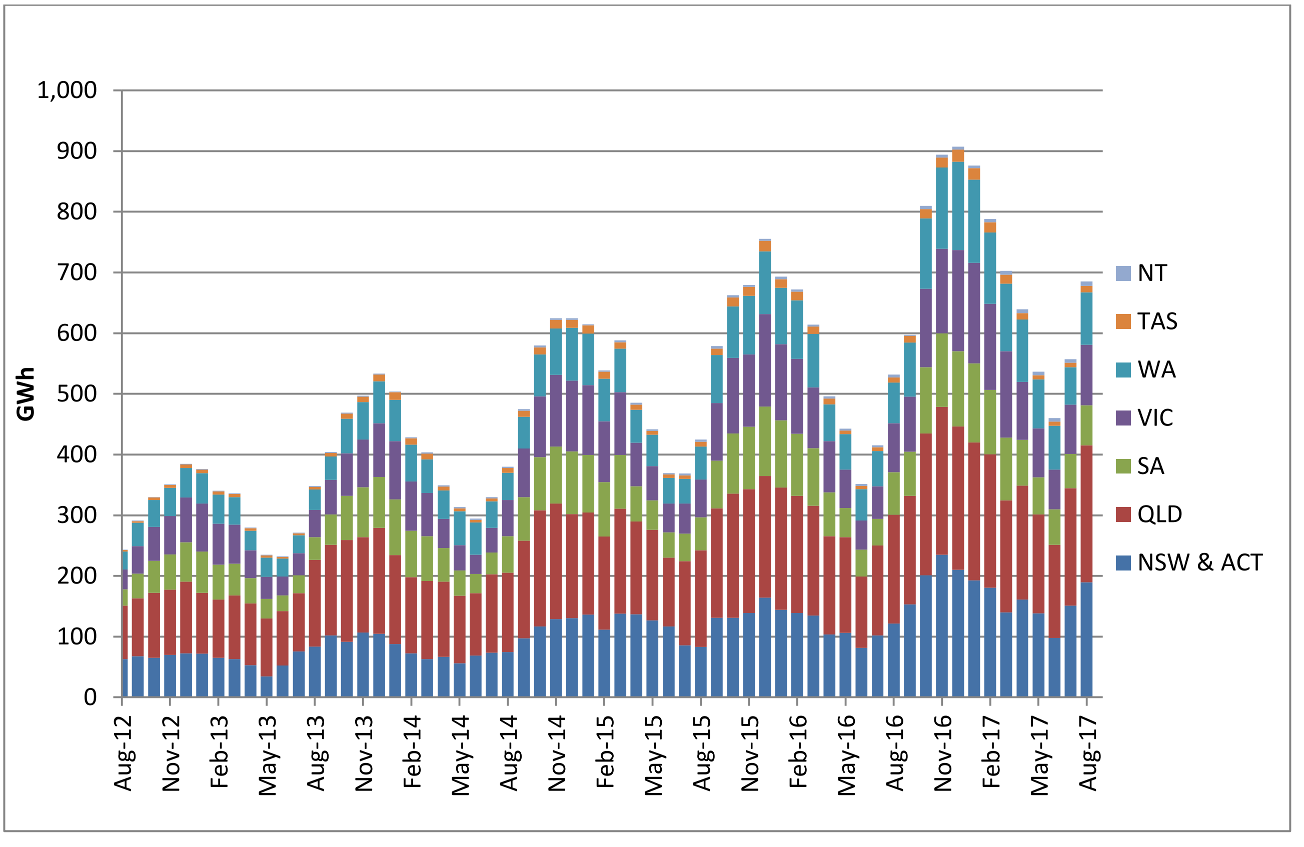
Factors such as the continued growth in renewables, stagnant demand and the planned retirements of older power stations are behind the expansion of grid-scale batteries with the main applications being the delivery of ancillary services, such as frequency control, to ensure reliability and to support demand shifting – storing energy during lower demand periods and discharging it during peak times. This is shown in Figure 5. The extent to which large-scale batteries like South Australia's 100MW system can help manage severe demand peaks such as in an extended heatwave will be watched with interest.

SECTION III: ESTIMATED RESIDENTIAL PV GENERATION

The estimated total output of solar systems in each jurisdiction since July 2012 is shown in Figure 6. The PV output is obtained by multiplying the efficiency factor of systems with the estimated MW capacity in each state (as described in Section 2 of this report).

The efficiency factor is calculated from PVoutput where self-selecting solar systems enter data into a database. Due to self-selection, the estimate may have an upward bias as self-selecting clients are more likely to maintain solar systems and therefore have a higher efficiency factor. Sample sizes for the Northern Territory and Tasmania are very small. The CER data may not accurately capture the rooftop PV generating capacity due to systems that have failed, and are no longer generating, or systems that have been upgraded but have not been notified to CER. All systems which are reported to the CER are assumed to be residential.

Figure 6: Estimated residential PV generation (GWh)



Source: Australian Energy Council analysis, 2017

Generation from PV increased 21 per cent in 2016-17; increasing from 6,738 GWh in 2015-16 to 8,157 GWh in 2016-17. New South Wales, Northern Territory and Western Australia experienced 33.9, 38.2, 35.8 per cent increases in generation respectively when compared to the previous year. Yet due to the extremely small share of total capacity in the Northern Territory, which only accounted for 0.7 per cent of the total generation for 2016-17, the increases in generation in this state is too insignificant.

Figure 6 shows increasing seasonal patterns, with PV generation low during May to July, while generation unsurprisingly reaches a peak during summer each year with its sunnier periods. December is consistently the highest month for PV electricity generation. The month of February shows a large decrease, largely due to only having 28 days in the month.

SECTION IV: LEVELISED COST OF ENERGY

The 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. We have calculated the LCOE for solar in Australia's major cities and below to indicative retail prices and current feed-in tariff (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 is released on a bi-annual basis. 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 2, 3 and 4 show the LCOE at across major cities at different discount rates.

It is a great news many electricity retailers raised their solar FiT which allow customer to choose the best quote price on their own. Householders will benefit a steep increase in solar FiT from around 5c/kWh to a minimum of 11.3c/kWh for their exports back to the grid in many states.

Please note that in Darwin, there is no 5kW pricing as Darwin installers prefer to list pricing for 4.5kW systems instead and as there are additional hurdles for connecting solar systems above that size to the grid.

Table 1: Central estimate: 6.64 per cent discount rate (ten-year average mortgage rate)

	System Size						Retail prices	FIT
All figures in c/KWh	**1.5**	**2**	**3**	**4**	**5**	**10**		
Adelaide	$0.16	$0.15	$0.13	$0.12	$0.11	$0.12	$0.48	$0.16
Brisbane	$0.17	$0.15	$0.13	$0.12	$0.12	$0.13	$0.33	$0.12
Canberra	$0.16	$0.15	$0.13	$0.12	$0.12	$0.13	$0.22	$0.13
Darwin	$0.28	$0.24	$0.20	$0.19	-	$0.14	$0.26	$0.26
Hobart	$0.22	$0.20	$0.18	$0.16	$0.16	$0.16	$0.25	$0.09
Melbourne	$0.21	$0.19	$0.16	$0.14	$0.14	$0.15	$0.26	$0.12
Sydney	$0.17	$0.16	$0.14	$0.13	$0.12	$0.13	$0.31	$0.13
Perth	$0.14	$0.12	$0.11	$0.10	$0.10	$0.12	$0.26	$0.07

Source: Australian Energy Council analysis, 2017

Table 2: Low cost of capital sensitivity: 5.22 per cent discount rate (low current standard variable rate)

	System Size						Retail prices	FIT
All figures in c/KWh	**1.5**	**2**	**3**	**4**	**5**	**10**		
Adelaide	$0.15	$0.14	$0.12	$0.11	$0.11	$0.12	$0.48	$0.16
Brisbane	$0.16	$0.14	$0.12	$0.12	$0.11	$0.12	$0.33	$0.12
Canberra	$0.15	$0.14	$0.13	$0.12	$0.11	$0.12	$0.22	$0.13
Darwin	$0.26	$0.22	$0.19	$0.17	-	$0.13	$0.26	$0.26
Hobart	$0.20	$0.18	$0.17	$0.15	$0.15	$0.15	$0.25	$0.09
Melbourne	$0.20	$0.17	$0.15	$0.14	$0.13	$0.14	$0.26	$0.12
Sydney	$0.16	$0.15	$0.13	$0.12	$0.11	$0.12	$0.31	$0.13
Perth	$0.13	$0.12	$0.11	$0.10	$0.09	$0.11	$0.26	$0.07

Source: Australian Energy Council analysis, 2017

Table 3: High cost of capital sensitivity: 14.14 per cent discount rate (indicative personal loan rate)

	System Size						Retail prices	FIT
All figures in c/KWh	**1.5**	**2**	**3**	**4**	**5**	**10**		
Adelaide	$0.23	$0.20	$0.18	$0.16	$0.15	$0.17	$0.48	$0.16
Brisbane	$0.24	$0.21	$0.18	$0.17	$0.16	$0.17	$0.33	$0.12
Canberra	$0.23	$0.21	$0.19	$0.17	$0.16	$0.17	$0.22	$0.13
Darwin	$0.41	$0.35	$0.29	$0.27	-	$0.19	$0.26	$0.26
Hobart	$0.31	$0.28	$0.25	$0.23	$0.22	$0.22	$0.25	$0.09
Melbourne	$0.31	$0.26	$0.23	$0.20	$0.19	$0.20	$0.26	$0.12
Sydney	$0.24	$0.22	$0.19	$0.17	$0.16	$0.18	$0.31	$0.13
Perth	$0.19	$0.17	$0.15	$0.14	$0.13	$0.16	$0.26	$0.07

Source: Australian Energy Council analysis, 2017

Small and Large business - Levelised Cost of Electricity

Tables 4 and 5 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 4 and 5 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[vi].

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[vii].

Table 4: Central estimate: 7.42 per cent discount rate, ten-year average small business interest rate

	System Size			
All figures in c/KWh	**10**	**30**	**50**	**100**
Adelaide	$0.13	$0.12	$0.12	$0.12
Brisbane	$0.13	$0.13	$0.12	$0.12
Canberra	$0.13	$0.12	$0.11	$0.11
Melbourne	$0.15	$0.15	$0.15	$0.14
Sydney	$0.13	$0.13	$0.13	$0.12
Perth	$0.12	$0.11	$0.12	$0.11

Source: Australian Energy Council analysis, 2017

Table 5: Central estimate: 5.52 per cent discount rate, ten-year average large business interest rate

	System Size			
All figures in c/KWh	**10**	**30**	**50**	**100**
Adelaide	$0.12	$0.11	$0.11	$0.11
Brisbane	$0.12	$0.12	$0.11	$0.11
Canberra	$0.12	$0.11	$0.10	$0.10
Melbourne	$0.14	$0.14	$0.13	$0.13
Sydney	$0.12	$0.12	$0.12	$0.11
Perth	$0.11	$0.10	$0.11	$0.10

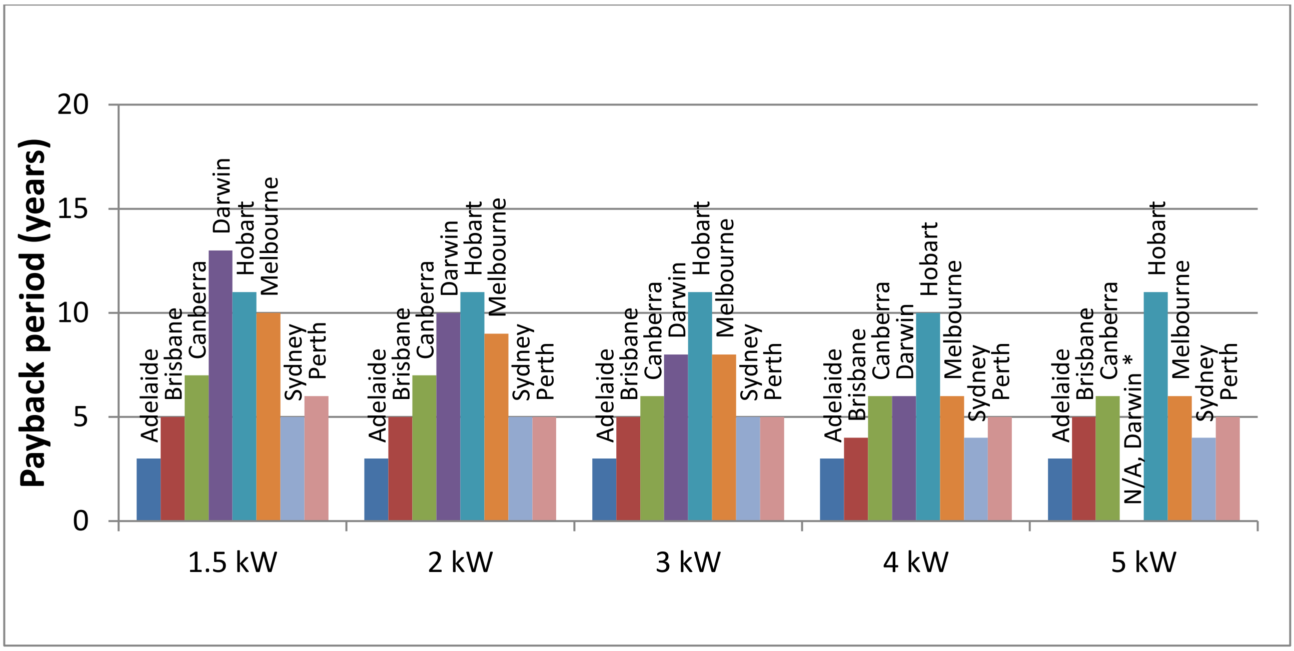
Source: Australian Energy Council analysis, 2017

SECTION V: 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 Feed in Tariffs (FiT). The cumulative cost incurred represents the initial investment and the time value of money. A detailed methodology is contained at Appendix 2.

Figure 7 highlights the payback period for different system sizes across Australia. Note that electricity prices are increased at CPI levels (currently 1.9 per cent) and if these prices rise above or below CPI, this will change the payback period.

Figure 7: Payback period for solar PV (5.22 per cent discount rate)



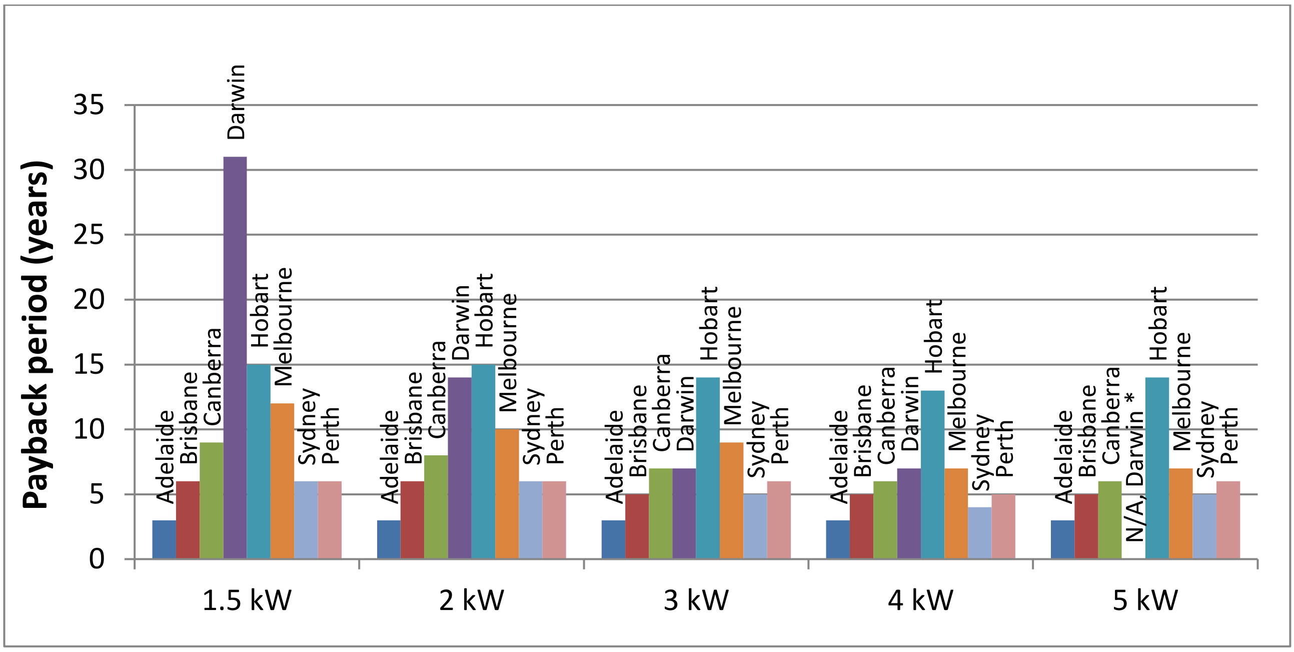
* In Darwin, there is no 5kW pricing as Darwin installers prefer to list pricing for 4.5kW systems instead and as there are additional hurdles for connecting solar systems above that size to the grid.

Source: Australian Energy Council analysis, 2017

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. Perth used to be the leading state with the lowest payback years, which has been taken over by Adelaide. Adelaide is currently having the constant lowest payback period of three years. Meanwhile, Brisbane, Perth and Sydney all have consistently low payback periods of no more than six years.

Figure 8 shows the expected payback period for systems with a 6.64 per cent discount rate (10-year average home loan rate). The trend is clear, the bigger the system, the lower number of years to pay back the loan for installing PV the customer will have.

Figure 8: Payback period for solar PV (6.64 per cent discount rate)



* In Darwin, there is no 5kW pricing as Darwin installers prefer to list pricing for 4.5kW systems instead and as there are additional hurdles for connecting solar systems above that size to the grid.

Source: Australian Energy Council analysis, 2017

Similarly, under the scenario where customers are buying a solar system with a personal loan where the minimum of the Big Four banks payback rate is currently 14.14 per cent, no payback period is less than 17 years, even in Adelaide.

SECTION VI: SOLAR NEWS ROUND UP

France to invest €7 billion in renewables by 2022, reduce connection cost

Under its 'Great Investment Plan 2018-2022', France intends to invest €20 billion in its energy transition, which comprises €7 billion for renewable energy, €9 billion for energy efficiency and €4 billion for an electric vehicle transition. This investment aims to increase clean energy deployment by 70 per cent over five years. On a side note, the French government is aiming to lower by up to 40 per cent the cost to connect small-scale installations of renewable energy and biogas.

Source: PV-tech, September 2017

Taiwan releases tentative renewable energy FiTs for 2018

With an expectation of an solar feed-in tariff reduction, Taiwan has released the tentative rates for the renewable sector in 2018. The tariff is set to reduce by about 11.77 per cent for large-scale rooftop sector and 1.8 per cent for small-sized rooftop installations. The rates will be lowered further in the second half of 2018 under the current plan.

Source: PV-tech, September 2017

APA Group receives approval for 240MW PV project in Queensland.

A 240MW solar farm development has been approved by The Western Downs Regional Council. The installation is expected to deliver between 150MW and 240MW of power into the national grid with up to 100MW of battery storage. The project will also employ about 450 workers during peak construction. This is the third renewable energy installation approved by the council in less than two months.

Source: PV-tech, September 2017

SECTION VII: METHODOLOGY APPENDIX

1. Solar installations methodology

Analysis from the Clean Energy Regulator's (CER) monthly released 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 [t] 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[viii], 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 (6.64 per cent).

The low discount rate sensitivity is based on the minimum variable home loan mortgage rate offered by the Big Four banks (currently 5.22 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 (14.14 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 5.42 per cent and the small business discount rate is 7.42 per cent.

The discount rate also takes into account the Consumer Price Index (CPI); this has been given a constant value of 2.5 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[ix]. 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% 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

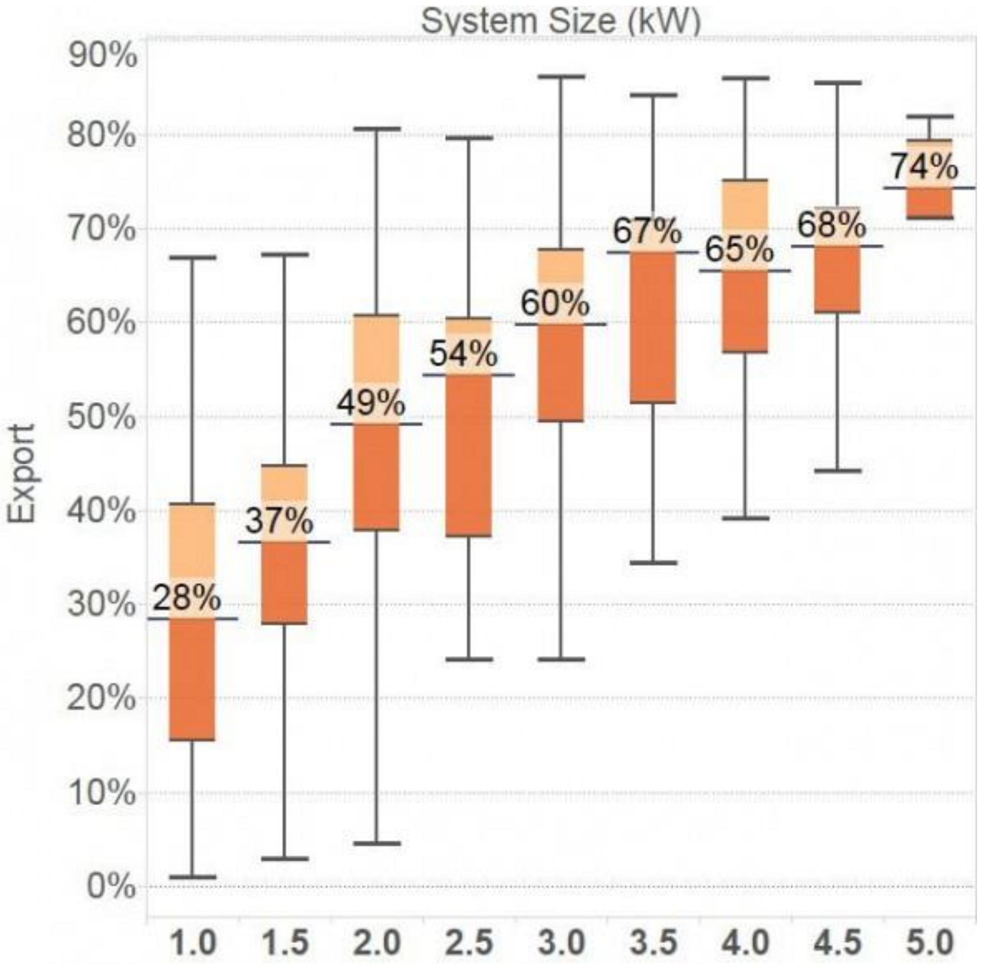
Avoided cost and FiT

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[x]. See Figure 6 below.

Figure 9: Export rate of residential solar PV at different system sizes



Source: Sunwiz analysis, 2015

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i 2017 Battery Market Report, Sunwiz Solar Industry Intelligence, 2017, page 3

ii 2017 Battery Market Report, Sunwiz Solar Industry Intelligence, 2017, page 3

iii All the Details on Tesla's Giant Australian Battery, July 2017.

iv Australia Behind-the-Meter PV and Storage Forecast, Bloomberg New Energy Finance, 2017, Research notes for subscribers.

v Australia Behind-the-Meter PV and Storage Forecast, Bloomberg New Energy Finance, 2017, Research notes for subscribers.

vi BCA, "Impact of Green Energy Policies on Electricity Prices", June 2014

vii 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

viii estimate based on, RenewEconomy, 26 August 2013, http://reneweconomy.com.au/2013/hidden-cost-of-rooftop-solar-who-should-pay-for-maintenance-99200

[ix] Clean Energy Council, http://www.solaraccreditation.com.au/dam/cec-solar-accreditation-shared/guides/Guide-to-installing-solar-PV-for-households.pdf
[x] Sunwiz, Solar Pays Its Way on Networks. Last accessed 17 June 2015.