AUSTRALIAN ENERGY COUNCIL

SOLAR REPORT

SEPTEMBER 2016

Australian Energy Council

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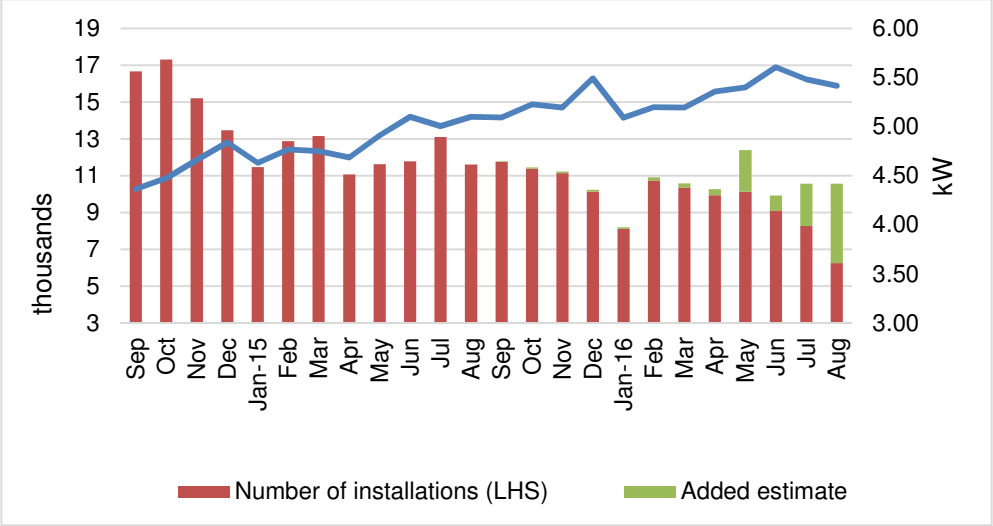
SECTION I: OVERVIEW OF SOLAR PV IN AUSTRALIA

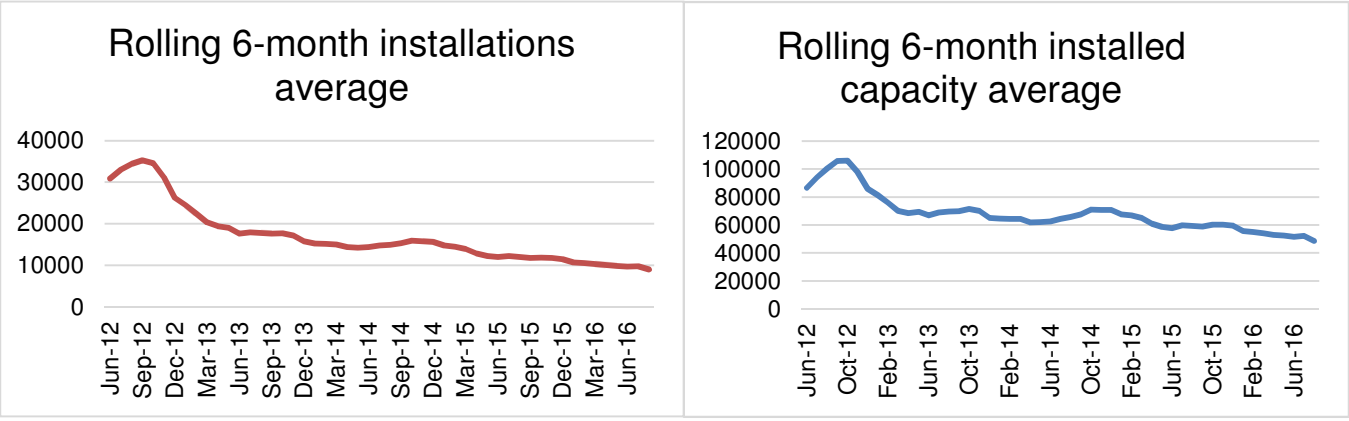
Individual State government mandated Feed in Tariffs (FITs) are one of the most influential factors in the rooftop solar market. As all of these generous schemes continue to close to new applicants, the rate of monthly solar photovoltaic (PV) installed capacity continues to decrease. Over the past 12 months, this has decreased by 20.59 per cent, compared to 11.64 per cent for the same period last year. Between January and December 2015, the average system size increased from 4.63 kW to 5.48 kW per installation. As of August 2016, average system sizes have fallen to 5.42 kW. Figure 1 shows the cumulative capacity over the last two years and the average monthly system size installed across Australia. Australia currently has 1.58 million solar PV installations as at 1 September 2016.

Figure 1: Installed solar PV and average system size



If we look at the number of installations and capacity over the same period (Figure 2), the downward trend is clearer. System costs continue to decline and households are opting for bigger systems, resulting in less change to the total installed capacity. Monthly installation rates have been skewed in the past, as states rolled back generous FiTs to a mandatory minimum or market-based FiT. This led to spikes in the number of installations as customers raced to meet the cut-off dates to be eligible.

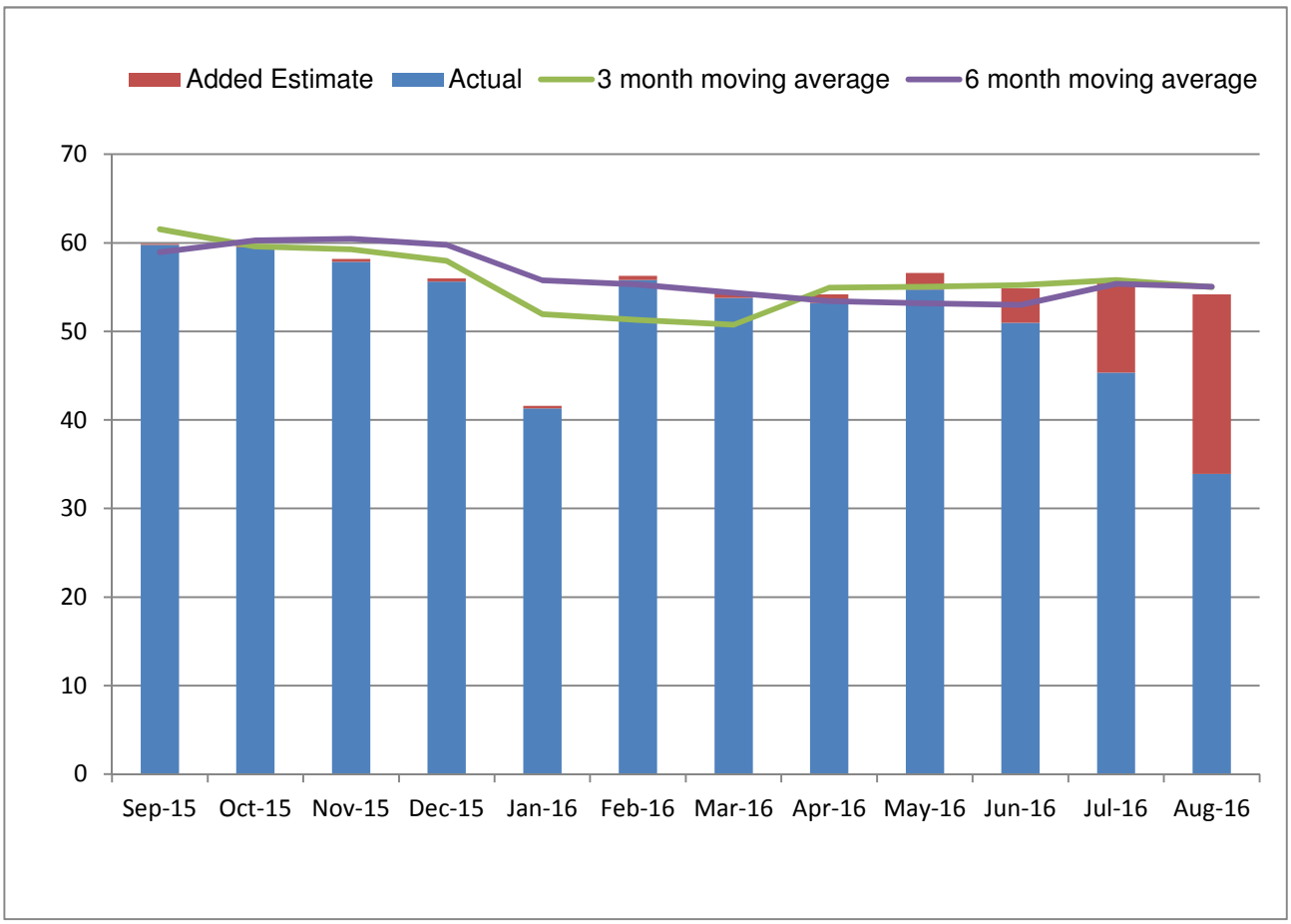
Figure 2: Solar PV installations and capacity in Australia, rolling six-month average



SECTION II: RECENT INSTALLATION RATES OF SOLAR PV

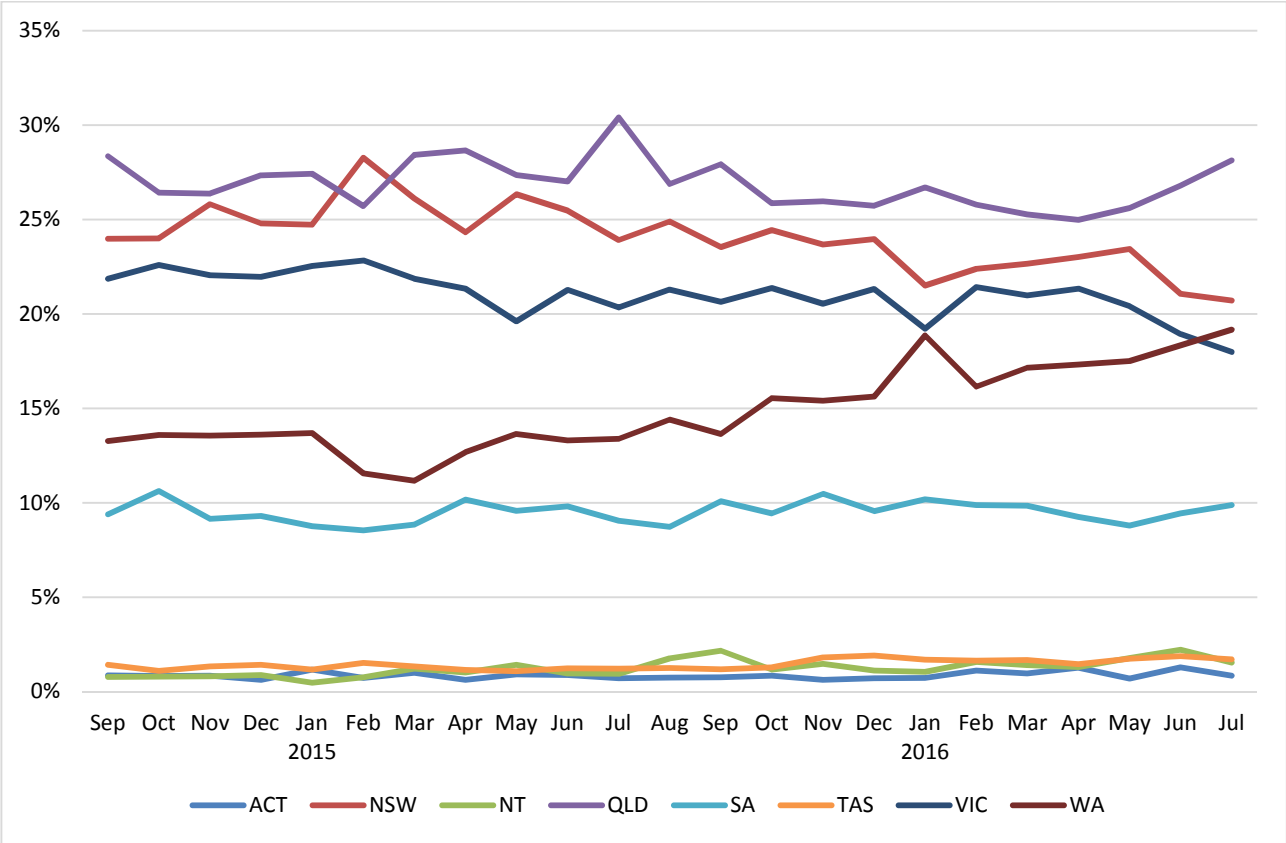
Analysis from the Clean Energy Regulator's (CER) most recent data allows us to estimate the amount of solar PV installed in Australia and the rolling average for new installations. As of November 2015, the CER has consistently released data dated as at the 1st of each month. Previously, the data was released intermittently throughout the 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, the CER data takes up to 12 months to be finalised. Figure 3 shows the actual and estimated capacity additions across Australia from September 2015 to August 2016.

Figure 3: Estimated monthly solar PV installed capacity (MW)



At the state level, Figure 4 shows the proportion of each month's solar PV capacity that has been installed in each state within the last two years. This provides more insightful trends of how uptake is shifting in each state and territory. The Northern Territory and the ACT have been excluded, due to their small population size.

Figure 4: Proportion of monthly installed solar PV capacity by state



Note: August figures have been excluded from the chart

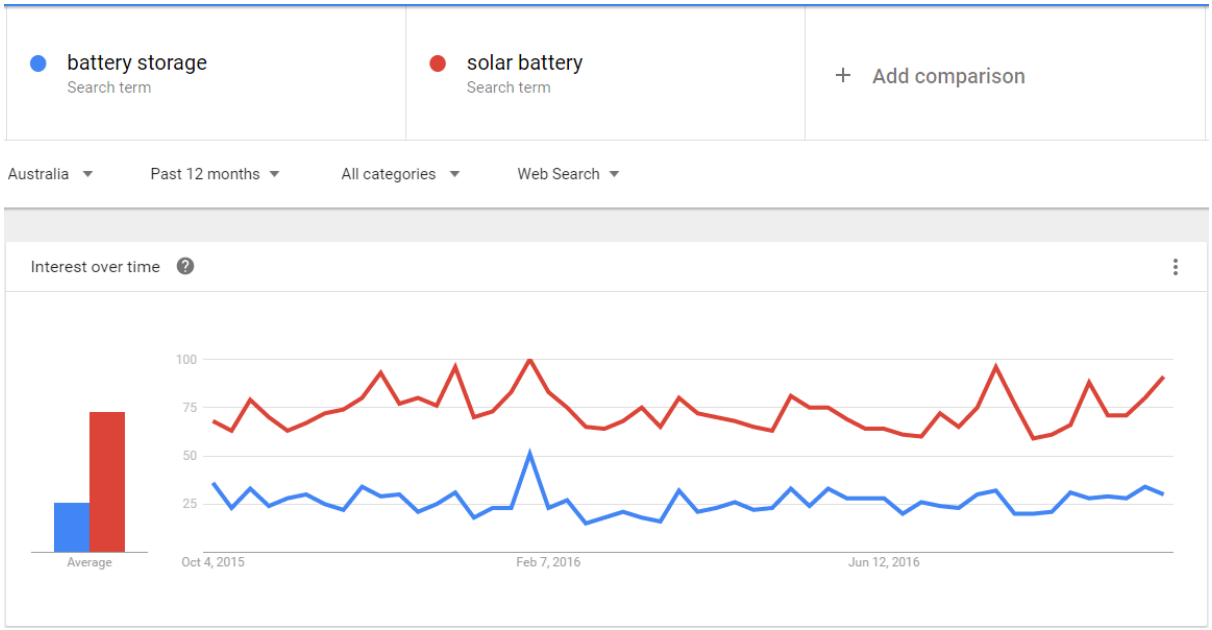
Australia's small scale solar PV systems have a collective capacity of 5,102,472 MW. Queensland remains the largest state, accounting for nearly a third of total installed capacity in Australia as at 1 September 2016. The popularity of solar PV continues to increase in Western Australia each month with installed capacity reaching 19.17 per cent of total installations in the month of July 2016. The increased interest in solar PV is in part driven by the economics of solar panels in WA as highlighted in Sections 4 and 5, which show that the payback period and the Levelised Cost of Electricity (LCOE) is extremely favourable in Perth.

SECTION III: "SOLAR BATTERY" VERSUS "BATTERY STORAGE"

The solar feed-in-scheme of 16 cents per kilowatt-hour (c/kWh) ceased in South Australia on 30 September 2016. Any new applicant seeking permission to connect their solar system to the grid may only be eligible for a minimum payment from their electricity retailer for any access electricity they export to the grid. The minimum retailer payment in 2016 is 6.8 c/kWh. However, the price paid to customers will increase depending on retail offers.

Using Google Trends Explorer, a tool that shows how often people search for certain terms in Google Search over time by geographical area. In Australia "Solar battery" has been searched more than the term "battery storage" (see Figure 5). Indicating people with solar panels are extremely interested in the emerging technology.

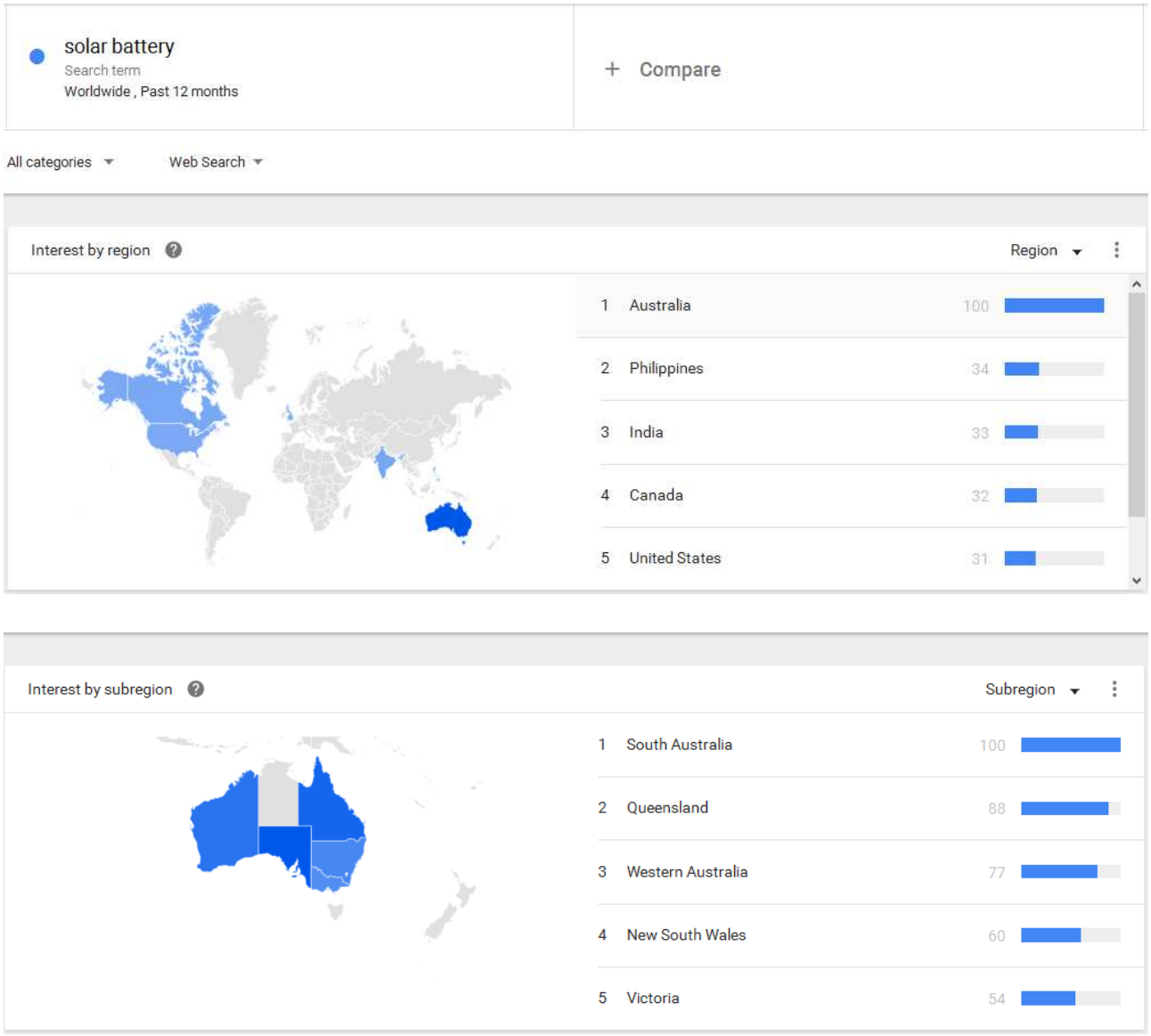
Figure 5: Australian Google Trends Explorer of "solar battery" and "battery storage" terms



While battery storage is uneconomical in most cases, the closure of FiTs may result in more Australians researching the new product to see if installation is beneficial for them. South Australians on the 44 c/kWh feed-in tariff are unlikely to be motivated to install battery storage. However, those on the 16 c/kWh rate may begin to consider batteries before the 16c/kWh rate expires on 30 September 2016.

It is interesting to see that either the "solar battery" or "battery storage" terms have been mostly looked up on Google in Australia when compared to other countries (see Figure 6, 7). Searches in other countries account for less than a third relative to Australian searches.

Figure 6: Google Trends Explorer of "solar battery" in the world and Australia

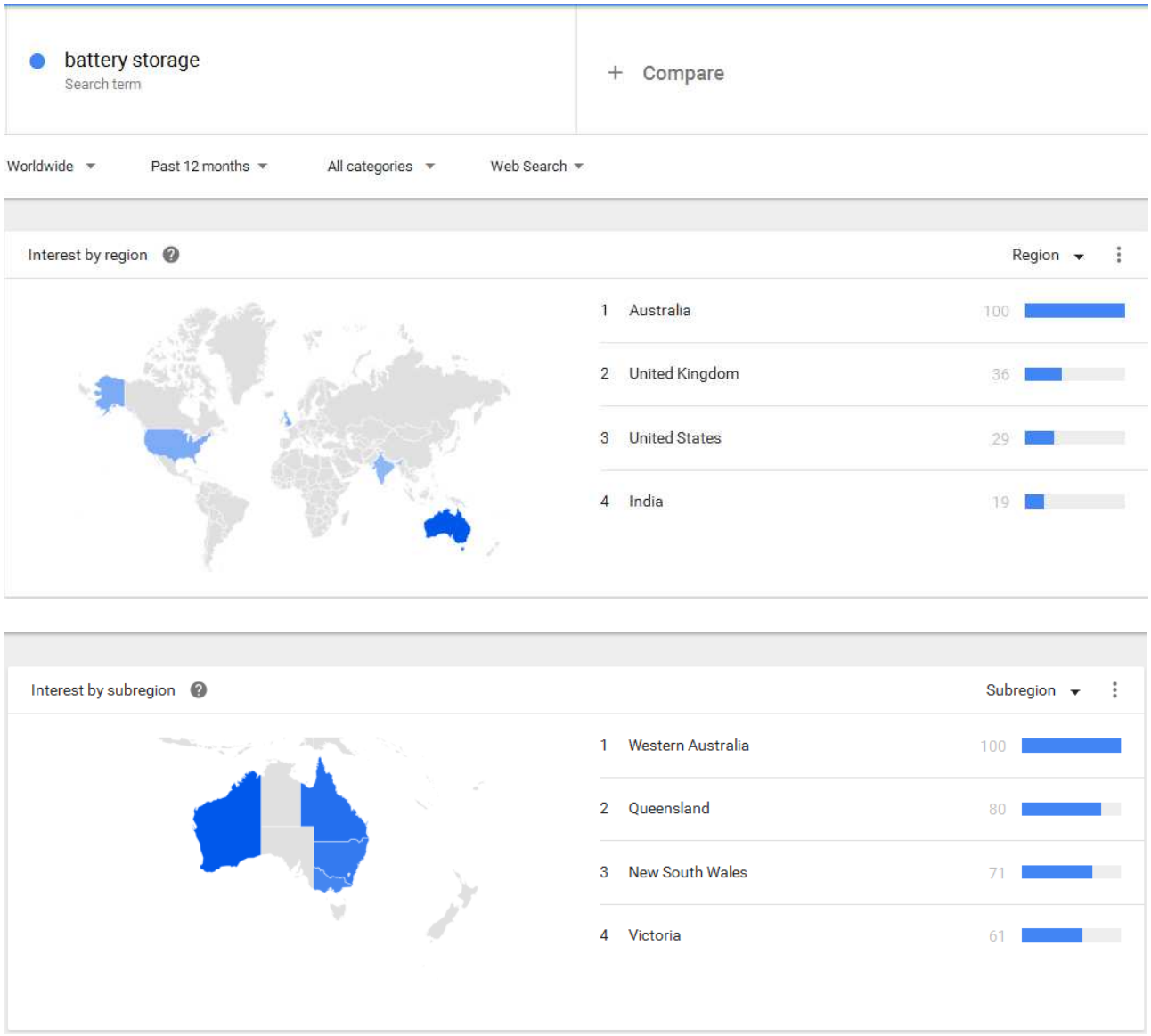


At regional level, the word combination "solar" and "battery" storage appears to have gained the most attraction in South Australia. It is evident that home battery storage is quickly capturing the minds of many South Australian residents (see Figure 6) in the past 12 months. A value of 100 in South Australia represents the peak interest, while Queensland has an interest rate of 88 per cent relative to South Australia. SA and QLD residents' PV penetration levels fast approaching one-third of all households helps explain their interest in storage systems. Similarly, Western Australia comes in at third place, with solar PV panels on one in five households[1].

"Battery storage" has been searched the most in WA, followed by QLD, NSW and VIC, since it is the way for homes with no solar FiT to ensure they self-consume more of their solar energy, rather than exporting into the grid at low rate.

[1] https://onestepoffthegrid.com.au/australias-top-solar-states-and-suburbs/

Figure 7: Google Trends Explorer of "battery storage" in the world and Australia



AEMO's recently report National Electricity Forecasting Report forecasted 3.8 GW of rooftop PV capacity would integrate battery storage, providing 6.6 GWh of energy storage potential. Battery installed in conjunction with solar systems is described as an Integrated PV and Storage System (IPSS). The most recent COAG meeting discussed the implementation of a battery storage database which would allow rule makers, regulators and analysts to monitor the uptake of battery storage.

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 FiT rates. The detailed methodology can be found in Appendix 1.

The retail comparison rates are representative of the variable rates and do not include supply charges. For all capital cities, excluding Perth and Hobart, charges 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 the Jacana Energy's regulated residential usage charges. Tables 1, 2 and 3 show the LCOE at across major cities at different discount rates.

(At the time of publication, St Vincent de Paul had not released the updated energy pricing for NSW.)

Table 1: Central estimate: 6.91 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	$0.18	$0.16	$0.14	$0.13	$0.12	$0.13	$0.37	$0.05
Brisbane	$0.16	$0.15	$0.13	$0.12	$0.12	$0.13	$0.27	$0.06
Canberra	$0.20	$0.18	$0.15	$0.14	$0.13	$0.13	$0.18	$0.08
Darwin	$0.26	$0.23	$0.20	$0.18	$0.19	$0.15	$0.26	$0.19
Hobart	$0.24	$0.21	$0.20	$0.18	$0.17	$0.17	$0.26	$0.06
Melbourne	$0.21	$0.19	$0.16	$0.15	$0.14	$0.14	$0.26	$0.06
Sydney	$0.18	$0.16	$0.15	$0.13	$0.13	$0.14	$0.29	$0.06
Perth	$0.13	$0.12	$0.11	$0.10	$0.10	$0.12	$0.26	$0.07

Table 2: Low cost of capital sensitivity: 5.35 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	$0.16	$0.15	$0.13	$0.12	$0.12	$0.12	$0.37	$0.05
Brisbane	$0.15	$0.14	$0.12	$0.11	$0.11	$0.12	$0.27	$0.06
Canberra	$0.19	$0.16	$0.14	$0.13	$0.12	$0.12	$0.18	$0.08
Darwin	$0.24	$0.21	$0.18	$0.17	$0.17	$0.14	$0.26	$0.19
Hobart	$0.22	$0.20	$0.18	$0.17	$0.16	$0.16	$0.26	$0.06
Melbourne	$0.19	$0.17	$0.15	$0.14	$0.13	$0.14	$0.26	$0.06
Sydney	$0.17	$0.15	$0.14	$0.12	$0.12	$0.13	$0.29	$0.06
Perth	$0.12	$0.11	$0.10	$0.10	$0.09	$0.12	$0.26	$0.07

Table 3: High cost of capital sensitivity: 14.01 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	$0.25	$0.22	$0.19	$0.17	$0.17	$0.17	$0.37	$0.05
Brisbane	$0.23	$0.21	$0.18	$0.17	$0.16	$0.17	$0.27	$0.06
Canberra	$0.29	$0.25	$0.21	$0.19	$0.18	$0.17	$0.18	$0.08
Darwin	$0.37	$0.32	$0.28	$0.26	$0.27	$0.21	$0.26	$0.19
Hobart	$0.34	$0.30	$0.27	$0.25	$0.24	$0.23	$0.26	$0.06
Melbourne	$0.29	$0.26	$0.22	$0.20	$0.19	$0.19	$0.26	$0.06
Sydney	$0.25	$0.22	$0.20	$0.17	$0.17	$0.18	$0.29	$0.06
Perth	$0.18	$0.17	$0.14	$0.13	$0.13	$0.17	$0.26	$0.07

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[i].

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[ii].

Table 4: Central estimate: 7.70 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	$0.11
Brisbane	$0.13	$0.12	$0.12	$0.12
Canberra	$0.13	$0.12	$0.12	$0.11
Melbourne	$0.15	$0.14	$0.15	$0.14
Sydney	$0.14	$0.13	$0.13	$0.13
Perth	$0.13	$0.12	$0.13	$0.12

Table 5: Central estimate: 5.77 per cent discount rate, ten year average large business interest rate

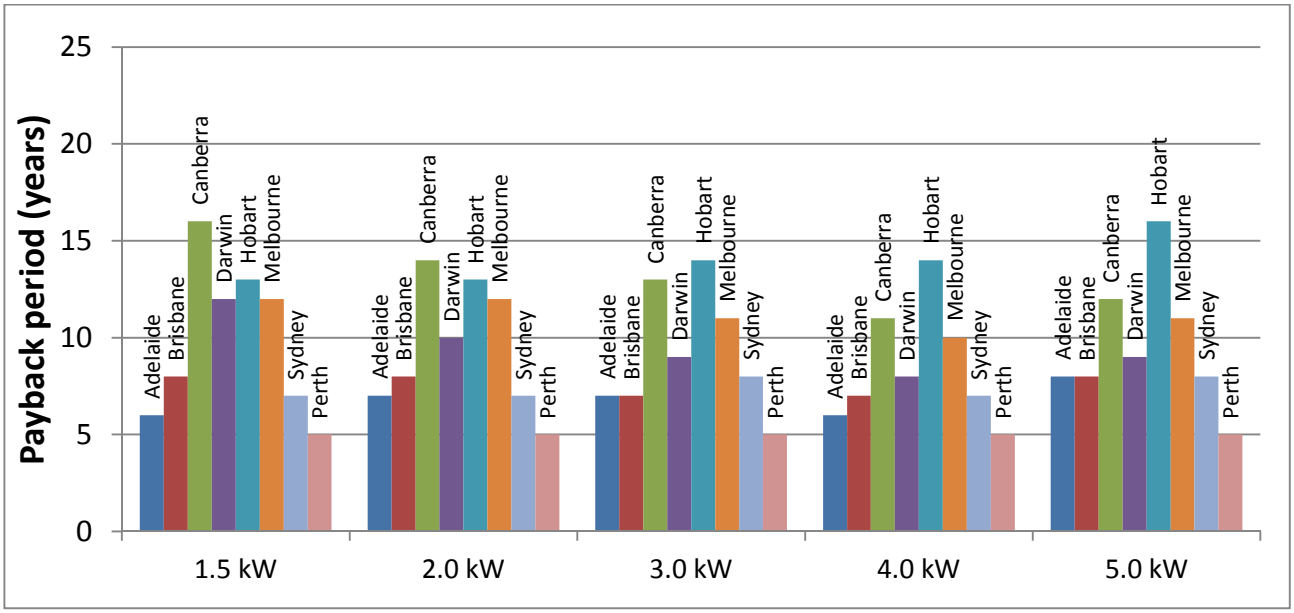
	System Size			
All figures in c/KWh	**10**	**30**	**50**	**100**
Adelaide	$0.12	$0.11	$0.11	$0.11
Brisbane	$0.12	$0.11	$0.11	$0.11
Canberra	$0.12	$0.11	$0.11	$0.10
Melbourne	$0.14	$0.13	$0.13	$0.13
Sydney	$0.13	$0.12	$0.12	$0.12
Perth	$0.12	$0.11	$0.12	$0.11

SECTION V: PAYBACK PERIOD, DETAILED MODEL

Using a similar methodology to that used to calculate the LCOE of solar PV in Australia (see Chapter 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 at Appendix 2. Payback period calculations include Darwin for the first time. Interestingly, Darwin has the highest cost of installations across Australia, but also has the highest FiT in Australia. This leads to a quicker payback period for larger systems due to assumed increases in exports to the grid.

Figure 8 highlights the payback period for different system sizes across Australia. Note that electricity prices are increased at CPI levels and if these prices rise above or below CPI, this will change the payback period

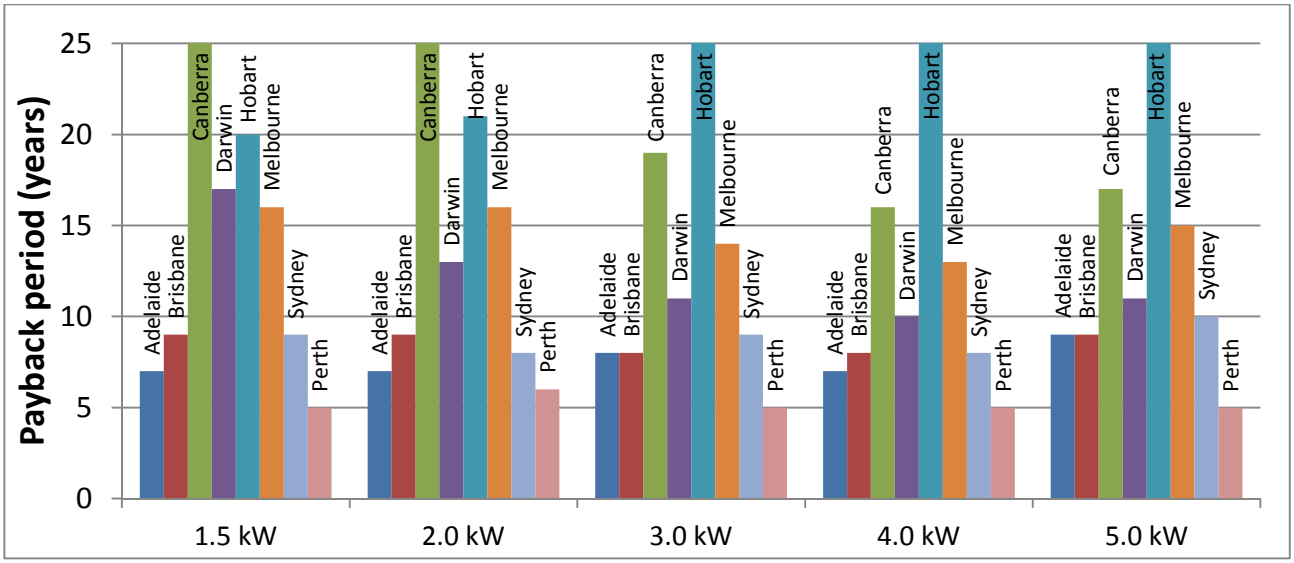
Figure 8: Payback period for solar PV (5.35 per cent discount rate)



Adelaide and Brisbane all have consistently low payback periods, no more than eight years, while Perth has a constant payback period of 5 years for all different system sizes. These three cities have high output rates with 4.2, 4.4 and 4.2 kWh produced on average each day for each kW of installed capacity (kWh/kW/day). Although Canberra sees similar rates of output (4.3 kWh/kW/day), electricity costs are the lowest in Australia, which changes the payback period. The calculated usage charge is 12 cents lower than the second lowest price in Australia and 15 cents lower than the highest.

Payback periods are extremely sensitive to the discount rate applied. Figure 9 shows the expected payback period for systems with a 6.91 per cent discount rate (10 year average home loan rate). This scenario suggests that Hobart's payback period exceeds 25 years for many large system sizes including 3 kW; 4 kW; 5 kW while Canberra is the opposite (longer payback period for smaller system sizes).

Figure 9: Payback period for solar PV (6.91 per cent discount rate)

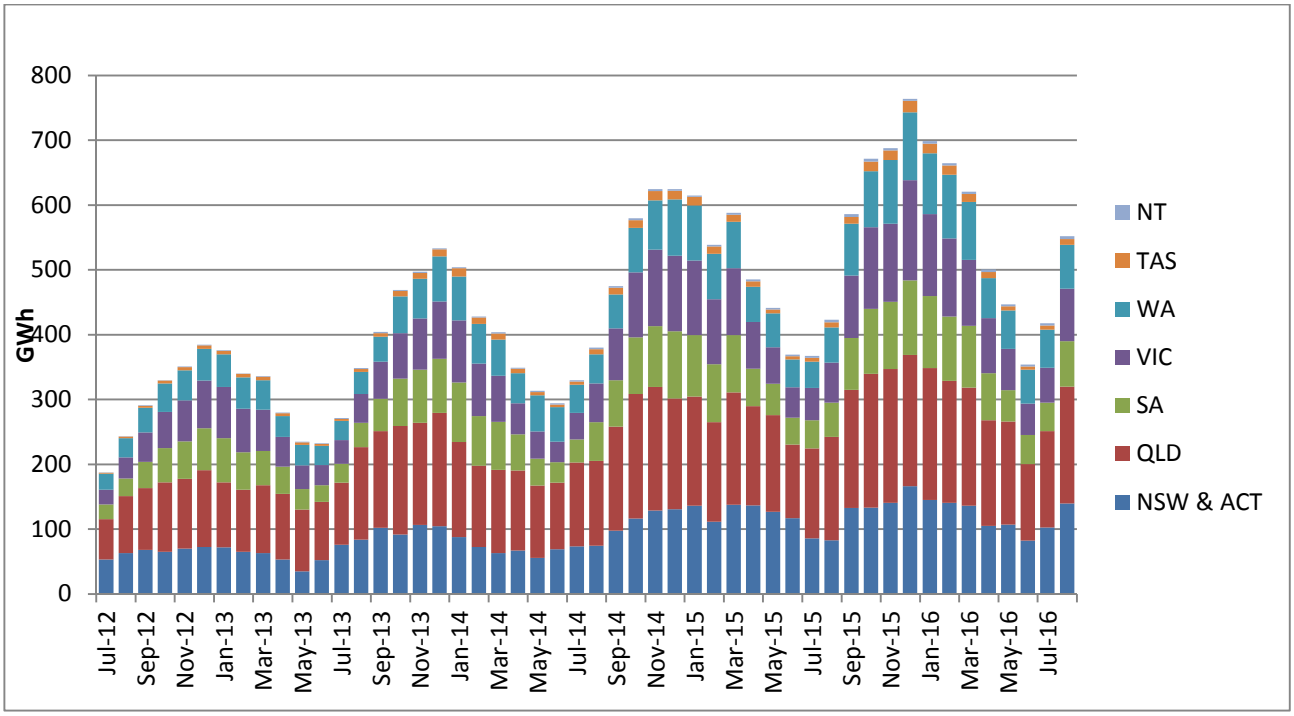


Under the scenario where customers are buying a solar system with a personal loan where the minimum of the Big Four banks payback rate is currently 14.01 per cent, no payback period is less than 25 years, even in Perth.

SECTION VI: ESTIMATED RESIDENTIAL PV GENERATION

Figure 10 shows the estimated total output of solar systems in each jurisdiction since July 2012. 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).

Figure 10: Estimated residential PV generation (GWh)



The efficiency factor is calculated from PVoutput.org 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.

The month of February 2016 shows a large decrease simply due to it being the shortest month.

SECTION VII: SOLAR NEWS ROUND UP

ARENA awards 482 MW of large scale projects grants

With an aim to triple solar installed capacity in 2017, the Australian Renewable Energy Agency made an announcement that it will fund 91.7 million to 12 large scale solar projects (482 MW in total). These projects are said to worth around 1.06 billion and are estimated to contribute around one-tenth of Australia's 2020 Renewable Energy Target.

Source: 8 September 2016, retrieved from PV-magazine

Microsoft sets New Renewable Energy Target of 50% in two years

Microsoft revealed that it is committed to improving its energy mix by increasing the percentage of solar, wind and hydropower energy to its data centre. Aiming for 50 per cent by 2018 and increasing to 60 per cent by 2020.

Source: 30 September 2016, retrieved from Cleantechnica

Granted consent for a 140 MW plant in Australia

UK solar developer Eco Energy World Australia received its planning consent last week for the Aramara solar farm in Queensland. It is currently planning to develop a 1GW of large-scale solar project, include sun-tracking technology over the next two years. The construction is expected to begin in early 2017 and the generation output will be sold directly to the market.

Source: 3 October, 2016, retrieved from RenewEconomy

SECTION VIII: APPENDICES

1. Appendix 1: 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[iii], 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 (6.91 per cent).

The low discount rate sensitivity is based on the minimum variable home loan mortgage rate offered by the Big Four banks (currently 5.35 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 (14.01 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 5.77 per cent and the small business discount rate is 7.70 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[iv]. 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.

2. Appendix 2: 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 $\sum$ savings > $\sum$ cost

Where:

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

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

t = years

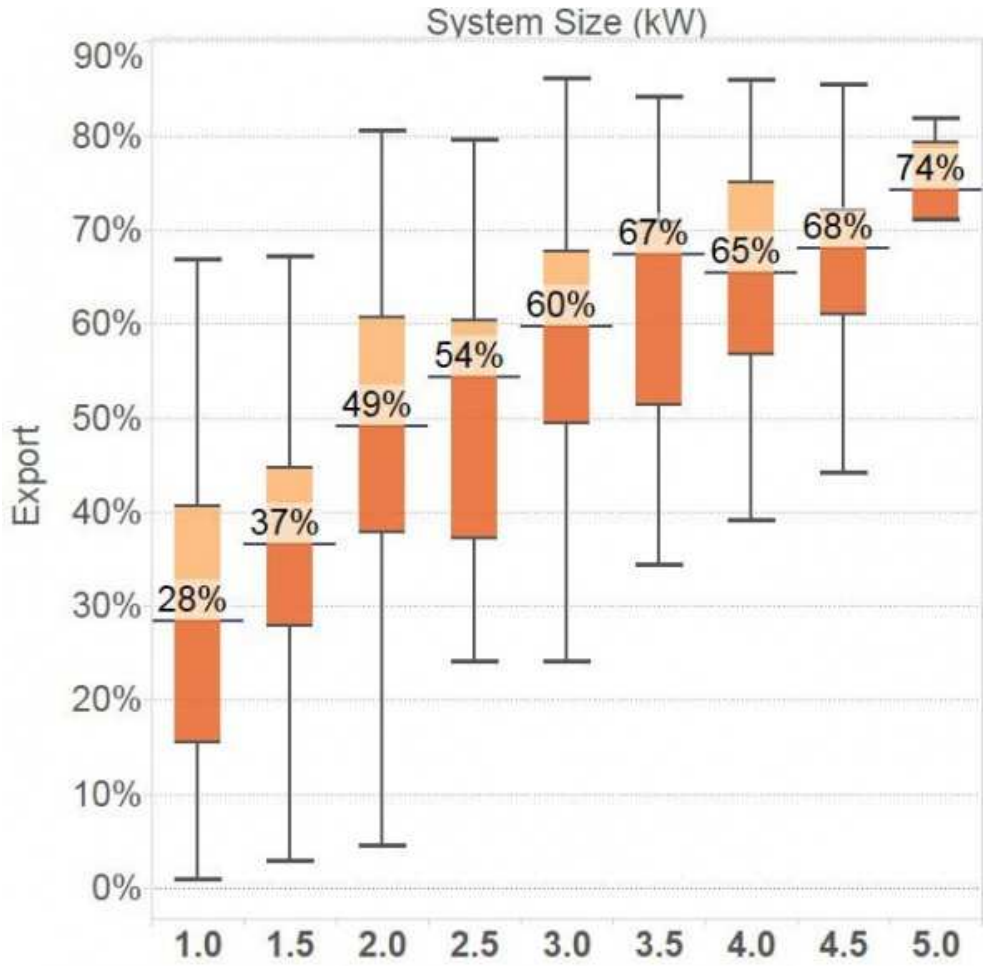
Avoided cost and FiT

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[v]. See Figure 6 below.

Figure 6: Export rate of residential solar PV at different system sizes



[ii] 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

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

[iv] Clean Energy Council, http://www.solaraccreditation.com.au/dam/cec-solar-accreditation-shared/guides/Guide-to-installing-solar-PV-for-households.pdf

[v] Sunwiz, Solar Pays Its Way on Networks. Last accessed 17 June 2015.