SOLAR REPORT

DECEMBER 2016

Australian Energy Council

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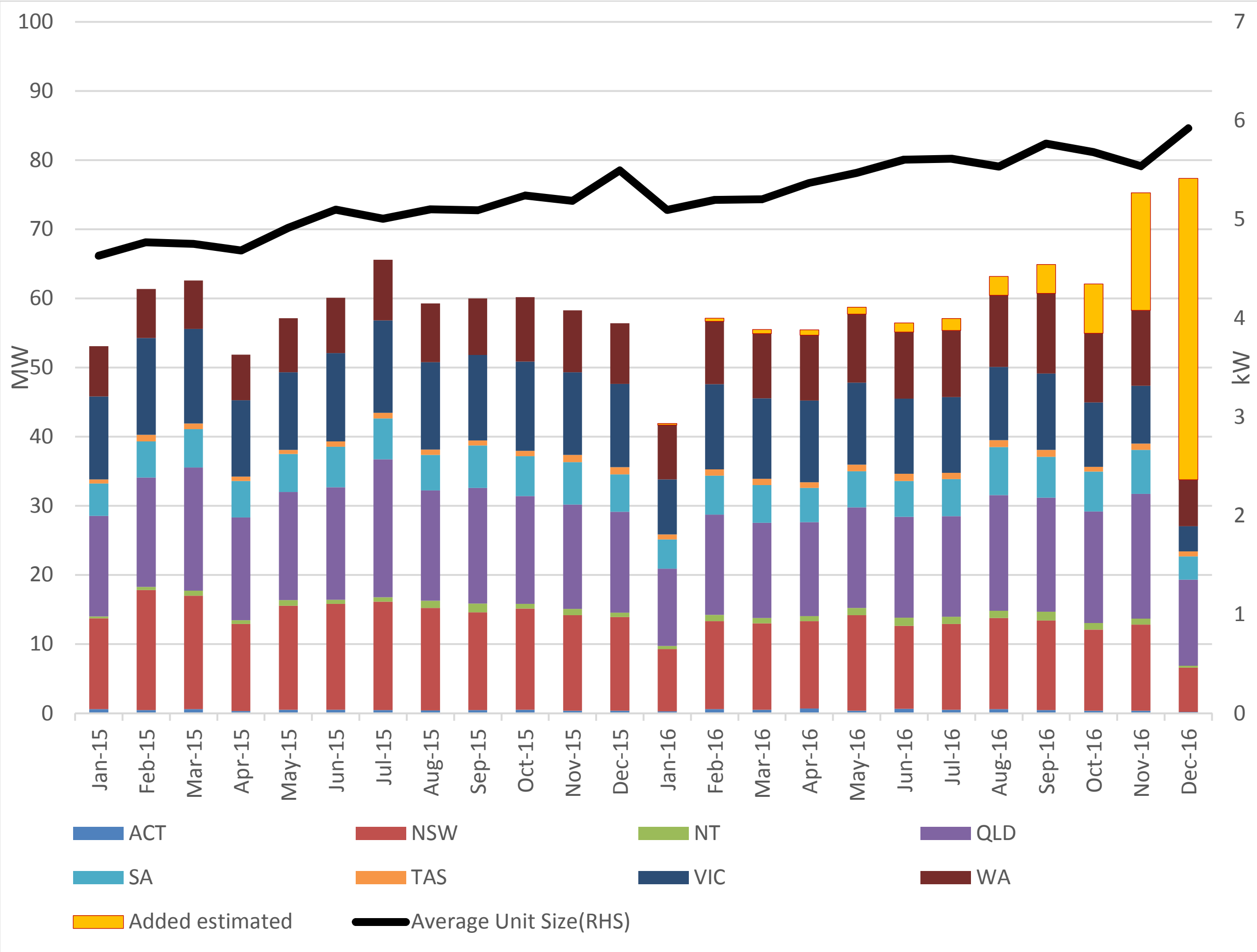
SECTION I: OVERVIEW OF SOLAR PV IN AUSTRALIA

Figure 1a shows the monthly installed capacity (the actual and estimated capacity additions[1]) at state level and the average system size over the last two years.

Figure 1a: Installed solar PV capacity and average system size



Source: Clean Energy Regulator (adjusted data)

The average system size appears to have taken a modest upturn, but it is too soon to see a clear trend. Monthly average installed capacity is 53.69MW for 2016, compared to 58.8MW in 2015.

[1] Due to the lag in reporting of new installations, actual CER data does not capture the true level of installations until several months have passed. Our approach for estimating the actual installation rate can be found in the Appendix.

The hot market for solar appears to be Western Australia, which is capturing an increasing share of the Australian market, as shown in Figure 1b below. The payback period and the Levelised Cost of Electricity (LCOE) is extremely favourable in Perth, as shown in Table 1 and Figure 2. The change in annual Western Australia solar installations is shown in Figure 4 (Section II). Solar also remains highly competitive in South Australia, which has increased its share of national capacity year-on-year.

Figure 1b: Proportional of yearly installed capacity across the states

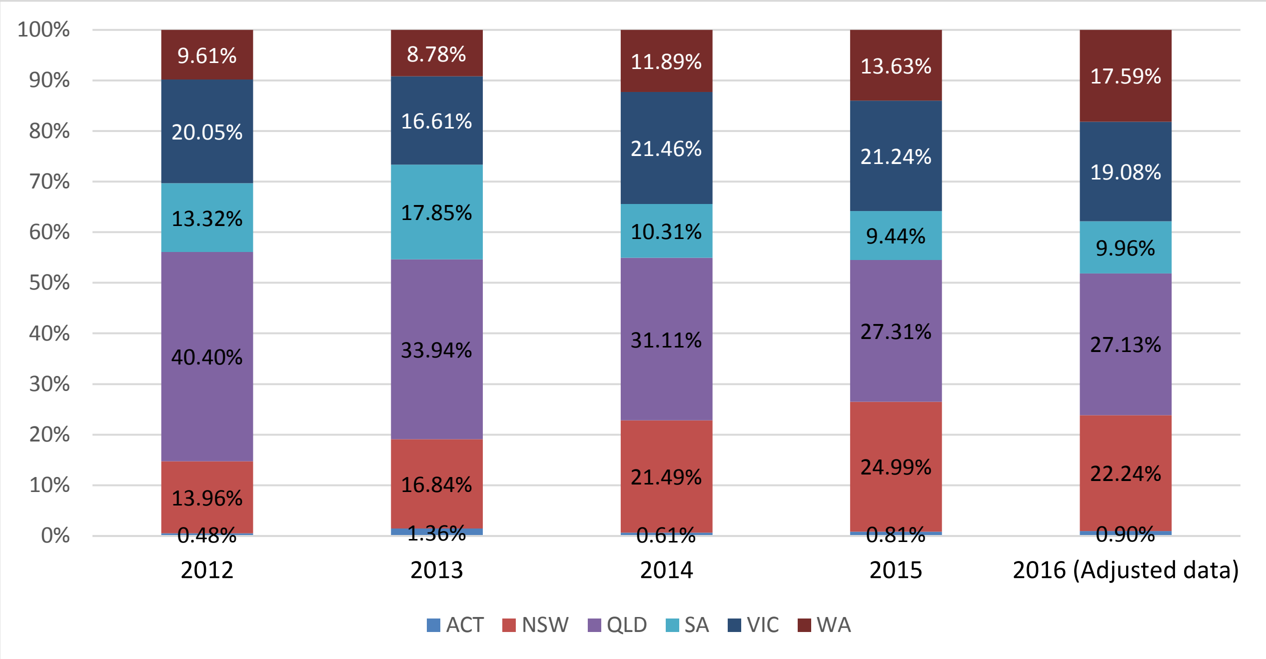
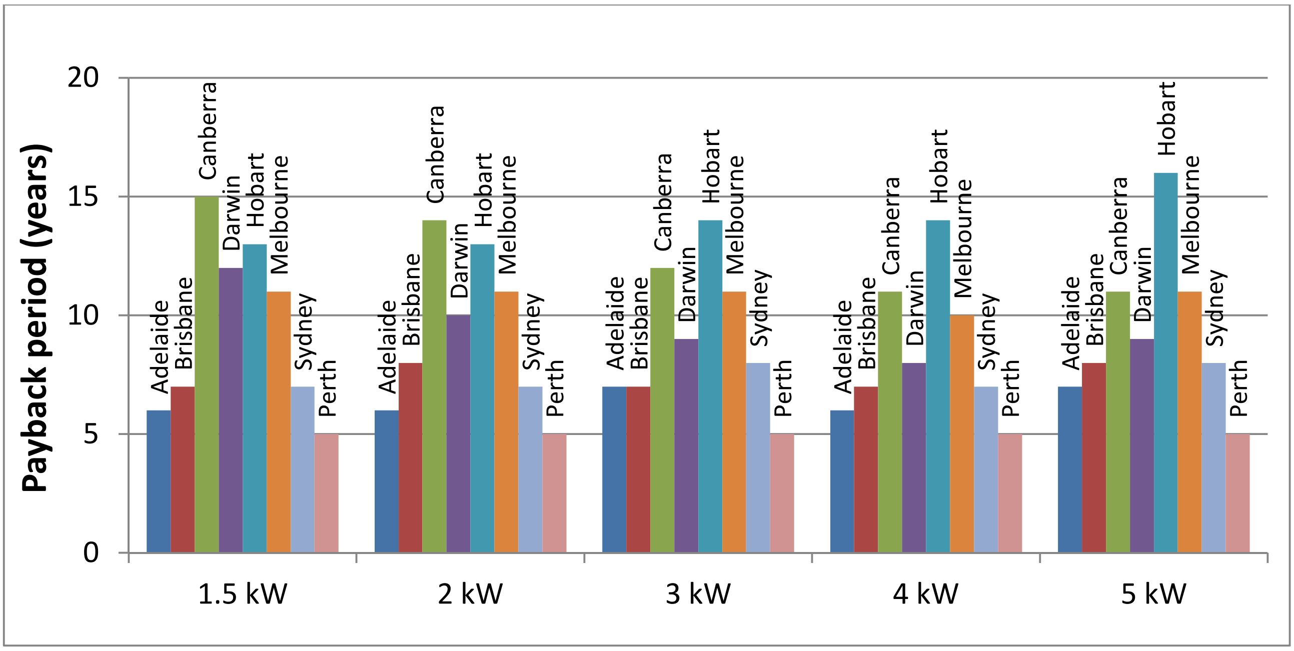


Table 1: Levelised cost of rooftop PV (central estimate) versus indicative retail charges and feed-in tariffs

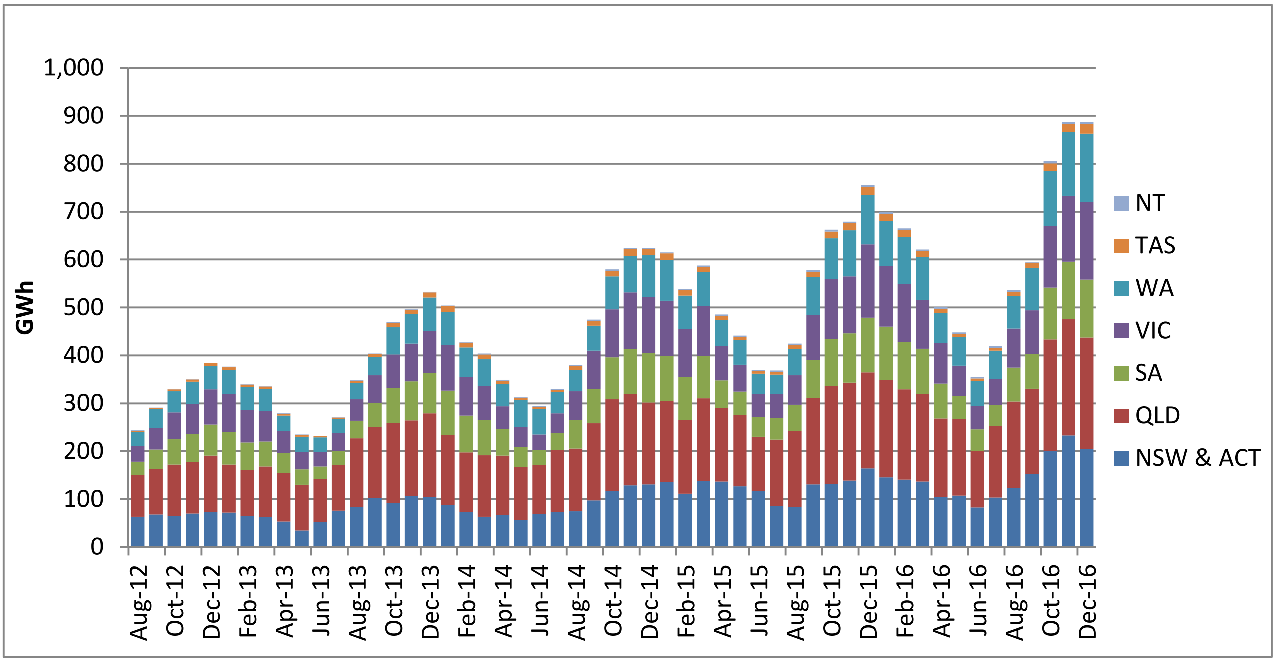
	System Size (KW)						Retail prices	FIT
All figures in c/KWh	**1.5**	**2**	**3**	**4**	**5**	**10**		
Adelaide	$0.18	$0.17	$0.15	$0.13	$0.13	$0.13	$0.40	$0.05
Brisbane	$0.16	$0.15	$0.13	$0.12	$0.12	$0.13	$0.31	$0.06
Canberra	$0.22	$0.19	$0.16	$0.15	$0.14	$0.13	$0.18	$0.08
Darwin	$0.30	$0.26	$0.21	$0.20	$0.15	$0.17	$0.26	$0.19
Hobart	$0.24	$0.21	$0.19	$0.18	$0.17	$0.17	$0.25	$0.06
Melbourne	$0.21	$0.19	$0.17	$0.15	$0.14	$0.15	$0.24	$0.07
Sydney	$0.18	$0.17	$0.14	$0.13	$0.13	$0.13	$0.27	$0.06
Perth	$0.13	$0.12	$0.11	$0.10	$0.10	$0.12	$0.26	$0.07

Figure 2: Payback period for solar PV (central estimate)



The continuing growth in capacity and the approaching summer meant that November was the biggest month ever for residential PV generation (Figure 3). All states except Queensland, New South Wales and the ACT, contributed more solar power output in December 2016, compared to previous months. For context, this represents less than 5 per cent of total generation.

Figure 3: Estimated residential PV generation (GWh)

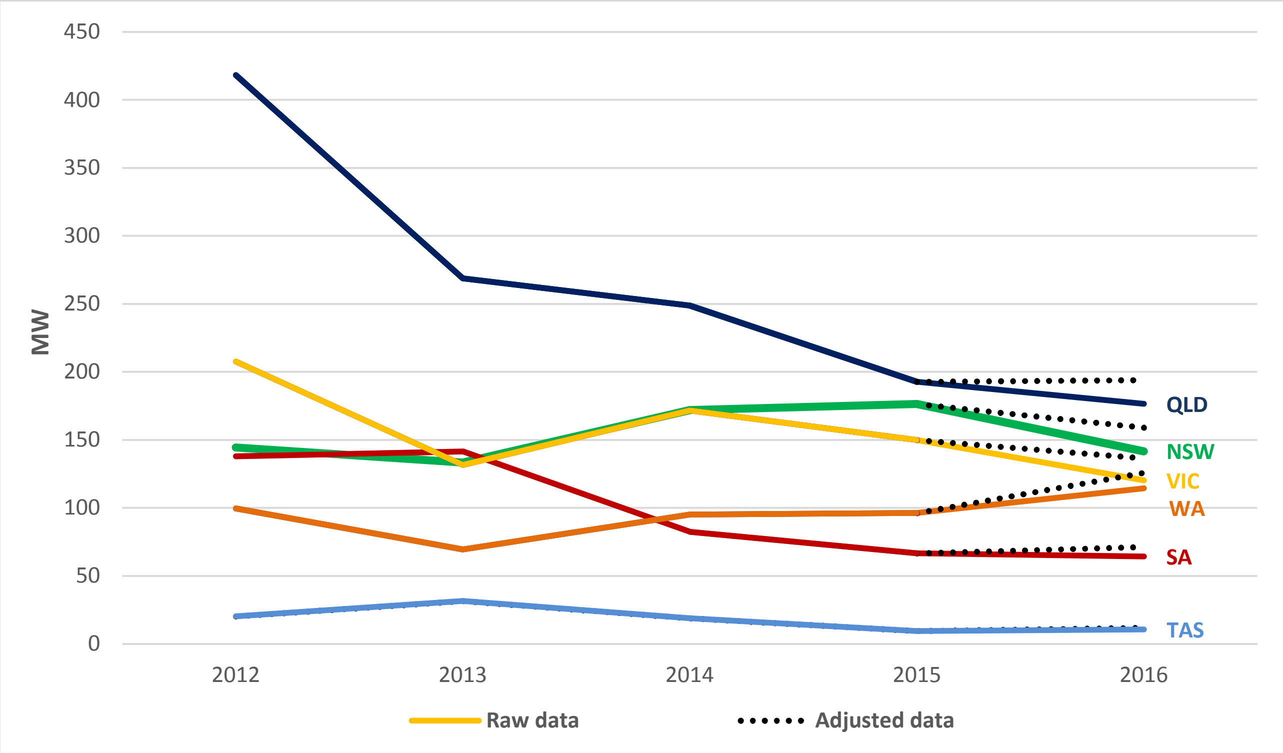


SECTION II: STATE UPDATE AND FEED-IN TARIFFS

In a number of major state markets, solar growth rates are continuing to slow down (figure 4). States like Queensland and South Australia already have substantial penetration rates for solar PV. Western Australia shows an increasing interest in installing solar PV, where it is now similar to Victoria's 2016 total installed capacity despite Victoria having a much larger population. This reflects the greater solar resource in Western Australia.

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

Figure 4: Total yearly solar PV installed capacity (MW) across the states



There was little change to the way feed-in tariffs were set during the last quarter of 2016, although there are some ongoing regulatory developments, and some legacy feed-in tariffs are expiring (though these should not impact installation rates going forward). A jurisdictional round-up follows:

New South Wales – the premium feed-in tariff (60c/kWh or 20c/kWh gross) came to its scheduled end on 31 December 2016. As the estimated 140,000 affected solar owners consider their options to maximise the value of their solar going forward, there may be opportunities for smart meter and battery installations.

Victoria – The government tasked the Essential Services Commission with reviewing the feed-in-tariff. While a “network benefit” element has been rejected, the government proposes to implement their recommendations to introduce an environmental benefit element and to introduce a mandatory time-varying tariff. The logic for the former is puzzling, given renewable energy certificates are still paid for small-scale installations and other consumers will bear the extra cost. The latter will be complex for retailers to adjust their billing systems for:

The Victorian Transitional Feed In Tariff (TFIT) of 25c/kWh closed on 31 December 2016.

South Australia – the Essential Services Commission has recommended removal of the minimum feed-in tariff. Additionally, one of the legacy feed-in tariffs (a 16c/Kwh payment) ended 30 September 2016.

Queensland, the ACT, Western Australia, Tasmania and the Northern Territory saw no changes to their feed-in-tariff policies in the last quarter of 2016.

SECTION III: SOLAR NEWS ROUND UP

US seeks to cut solar costs in half (again)

The US Department of Energy (DOE) SunShot Initiative is a national effort to cut the cost of solar electricity with the goal of making solar electricity cost-competitive with conventional sources of electricity by 2020, without subsidies. A new SunShot target was set in November, 2016 in the US to slash solar costs by an additional 50 per cent between 2020 and 2030[i]. More detail on this initiative can be found in Section 4.

Global solar manufacturing location trends in 2016

In 2016, Asia is said to has continued to dominate planned new PV manufacturing capacity expansions. The top seven countries (India, China, Vietnam, Malaysia, Thailand, South Korea and Taiwan) are all in Asia and accounted for around 46.2GW of new production plans from a total of around 49.2GW.

Source: PV-tech, Jan 2017

World's first solar road in France

The construction of one kilometre of solar road was begun around end of October last year. The project was financed by the French Energy Ministry and it had completed in December 2016. French officials have opened the route covered in 2,880 photovoltaic panels. It was said that the energy produced costs 13 times as much as rooftop panels.

Source: France24, Dec 2016

Large-scale solar tariff will be cut by 17% in China in 2017

In order to reflect on falling construction costs for solar, China will cut the amount paid to developers of solar farms by "as much as 19 per cent". This reduction is said to save the government AUD$1.18 billion a year.

Source: pv-magazine, Dec 2016

SECTION IV: SUNSHOT INITIATIVE'S 2030 TARGETS

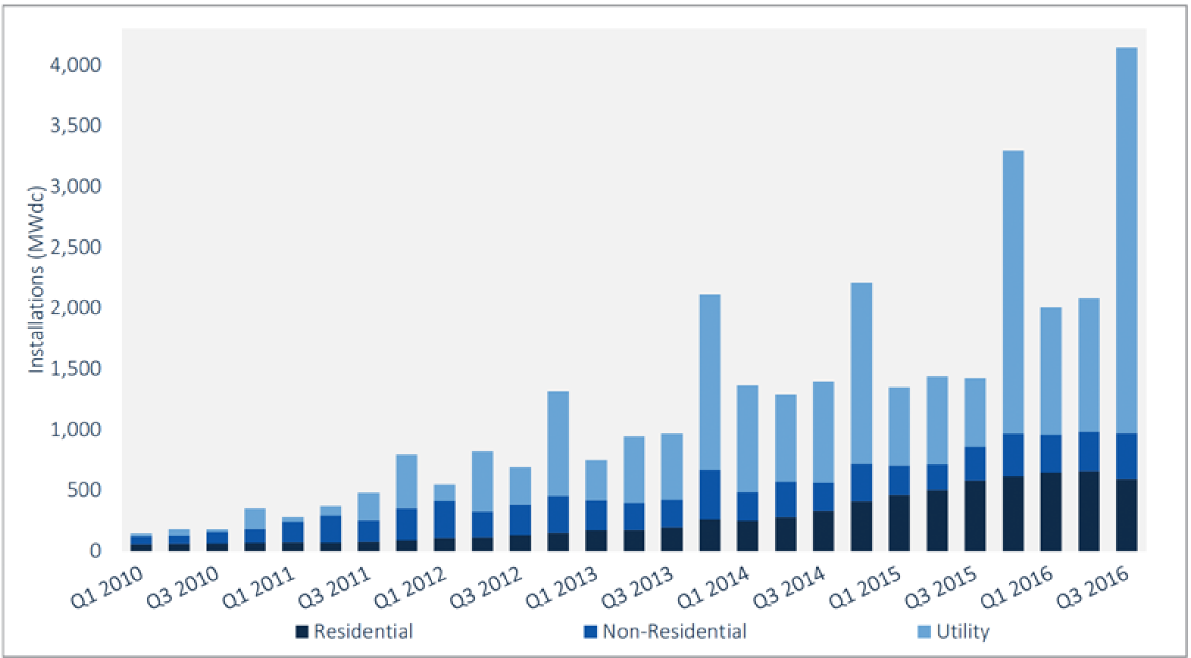
The US Department of Energy (DOE) SunShot Initiative is a national effort to cut the cost of solar electricity with the goal of making solar electricity cost-competitive with conventional sources of electricity by 2020, without subsidies. A new SunShot target was set in November, 2016 in the US to slash solar costs by an additional 50 per cent between 2020 and 2030[ii].

Since the SunShot Initiative began

The program was launched in 2011 by funding a wide-range of projects to improve PV performance, reliability, manufacturability and to implement higher market penetration for solar technologies. New research on improving power conversion efficiency and energy output is also being supported[iii]. By 2020, the SunShot Initiative aims to achieve unsubsidized LCOEs of 9 ¢/kWh for residential PV systems (smaller than 20 kW), 7 ¢/kWh for commercial PV systems (20 kW to 1.0 MW), and 6 ¢/kWh for utility-scale PV systems[iv].

Reaching the SunShot goals is expected to drive large-scale U.S. PV deployment. As can be seen in figure 5, the US Q3 2016 solar market installed 4,143 megawatts, which is an increase of eight fold from the same quarter in 2011. Utility PV segment which accounted for less than a-fifth of the Q1 2011 total installation, now accounts for roughly three-quarters of the Q3 2016 total installation.

Figure 5: Quarterly U.S Solar PV installations, Q1 2010- Q3 2016

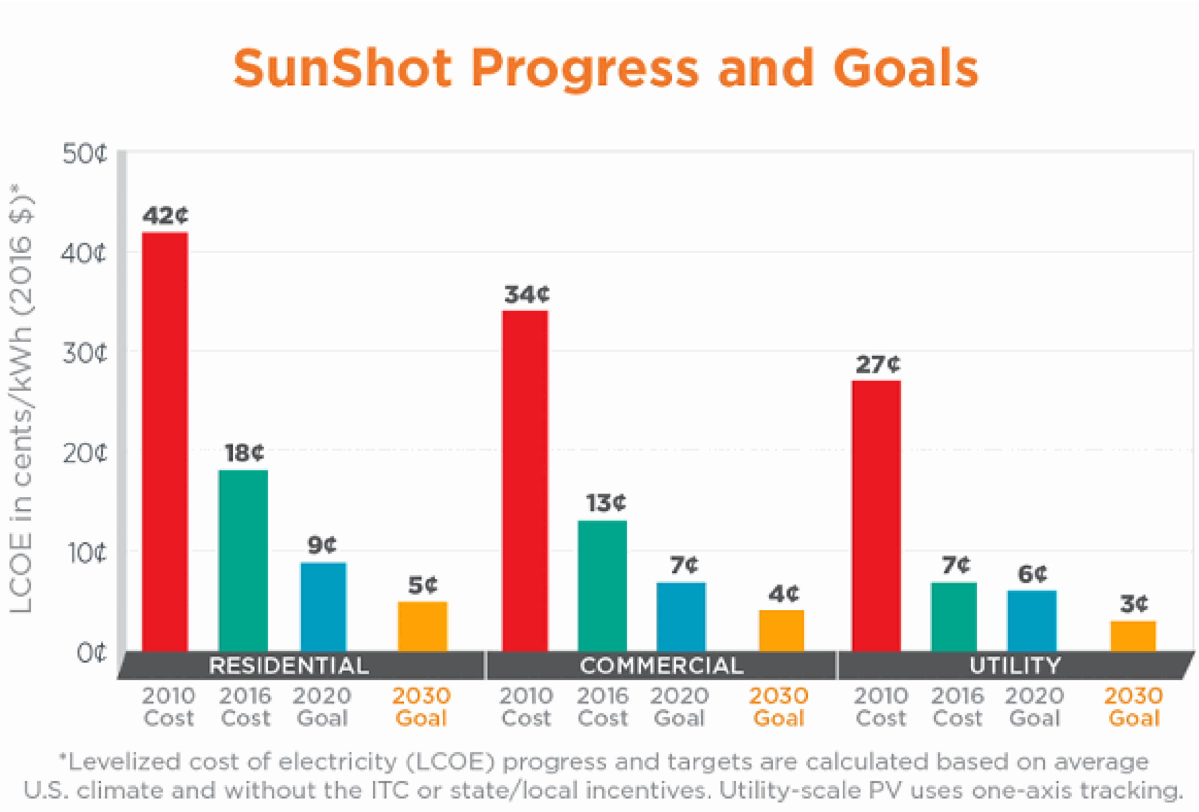


Source: Solar Energy Industries Association[v], 2016

SunShot 2030 Goals

In November 2016, the Department of Energy said that its multi-billion dollar SunShot program was approximately 90 per cent of the way to meeting the SunShot 2020 goals. The cost of solar energy has also dropped as much as 65 per cent[vi]. As the U.S solar industry made rapid progress toward the 2020 targets, the Department set a new target for 2030 where residential PV, commercial PV and utility-scale PV will be cut down to 5¢/kWh, 4¢/kWh and 3¢/kWh respectively. Figure 6 shows the remarkable drops in solar costs to date and the ambitions for 2020 and 2030.

Figure 6: U.S SunShot Initiative goals



Source: Office of Energy Efficiency & Renewable Energy[vii], 2016

Under this recent announcement of the new target, the DOE also announced $65 million in funding for the SunShot program[viii]. This funding also is expected to aid the SunShot's main mission well before 2020 by supporting on improving PV module design, advancing grid-integration facilitating commercialisation of solar and producing a better forecast of how much solar will be added to the grid.

What Australia can learn from the SunShot

Continuing to invest in solar technologies will help to drive down costs even further for American consumers. Beside SunShot Initiative, DOE also has a program called SunShot Incubator which assists start-up companies, established and non-profit organisations in developing an innovative solar concept and shortening time to make it commercially available. More than 130 projects receive SunShot funding through this program across the states in the US[ix]. Projects range from developing and launching transformative photovoltaic, concentrating solar power, to grid integration, system installation, and soft costs products and services.

The Australian Renewable Energy Agency (ARENA) has approximately $2 billion in funding, which is legislated and extends until 2022[x]. Its activities are mainly on advancing renewable energy technologies towards commercial readiness, improving business models or reducing overall industry costs. While deployment costs of solar PV has continued to drop in the past few years, ARENA chose to incentivise further deployment by granting funds to 12 different solar projects, the outcomes of which were announced last September[xi]. One thing ARENA does not do that SunShot does is that Sunshot invests many small funds to early stage start-ups, through a competitive selection process to a panel of experts[xii].

With the assistance of early-stage Incubator program, critical technological barriers are now addressed for the start-up businesses to ideally fit in private follow on funding. The Incubator program also permits entrepreneurs to devote effort to rapid commercialisation. SunShot Incubator program alone has granted A$187 million taxpayer dollars. In return, nearly A$4 billion have been raised in follow on investment from these small businesses. This remarks a success on reaching commercial maturity and job creation[xiii]. The former Director of DOE explained that this approach “has brought countless innovators” and unlocked talents through engaging partnerships between expert and research parties and local start-ups[xiv].

SECTION V: 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 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 1, 2 and 3 show the LCOE at across major cities at different discount rates.

Table 1: Central estimate: 6.82 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	$0.17	$0.15	$0.13	$0.13	$0.13	$0.40	$0.05
Brisbane	$0.16	$0.15	$0.13	$0.12	$0.12	$0.13	$0.31	$0.06
Canberra	$0.22	$0.19	$0.16	$0.15	$0.14	$0.13	$0.18	$0.08
Darwin	$0.30	$0.26	$0.21	$0.20	$0.15	$0.17	$0.26	$0.19
Hobart	$0.24	$0.21	$0.19	$0.18	$0.17	$0.17	$0.25	$0.06
Melbourne	$0.21	$0.19	$0.17	$0.15	$0.14	$0.15	$0.24	$0.07
Sydney	$0.18	$0.17	$0.14	$0.13	$0.13	$0.13	$0.27	$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: 5.25 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	$0.17	$0.15	$0.14	$0.12	$0.12	$0.12	$0.40	$0.05
Brisbane	$0.15	$0.14	$0.12	$0.11	$0.11	$0.12	$0.31	$0.06
Canberra	$0.20	$0.17	$0.15	$0.14	$0.13	$0.12	$0.18	$0.08
Darwin	$0.27	$0.23	$0.19	$0.18	$0.14	$0.16	$0.26	$0.19
Hobart	$0.22	$0.20	$0.18	$0.17	$0.16	$0.16	$0.25	$0.06
Melbourne	$0.19	$0.18	$0.15	$0.14	$0.13	$0.14	$0.24	$0.07
Sydney	$0.17	$0.15	$0.13	$0.12	$0.12	$0.13	$0.27	$0.06
Perth	$0.12	$0.11	$0.10	$0.10	$0.09	$0.11	$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	$0.26	$0.23	$0.21	$0.18	$0.17	$0.17	$0.40	$0.05
Brisbane	$0.23	$0.21	$0.17	$0.16	$0.16	$0.17	$0.31	$0.06
Canberra	$0.31	$0.26	$0.23	$0.21	$0.19	$0.17	$0.18	$0.08
Darwin	$0.43	$0.37	$0.30	$0.28	$0.21	$0.24	$0.26	$0.19
Hobart	$0.33	$0.30	$0.27	$0.25	$0.23	$0.24	$0.25	$0.06
Melbourne	$0.30	$0.27	$0.23	$0.20	$0.19	$0.20	$0.24	$0.07
Sydney	$0.26	$0.23	$0.20	$0.18	$0.17	$0.18	$0.27	$0.06
Perth	$0.18	$0.16	$0.14	$0.13	$0.12	$0.16	$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[xv].

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[xvi].

Table 4: Central estimate: 7.64 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	$0.12	$0.12	$0.12
Canberra	$0.13	$0.12	$0.12	$0.11
Melbourne	$0.15	$0.14	$0.14	$0.14
Sydney	$0.14	$0.13	$0.13	$0.13
Perth	$0.12	$0.11	$0.12	$0.12

Table 5: Central estimate: 5.69 per cent discount rate, ten-year average large business interest rate

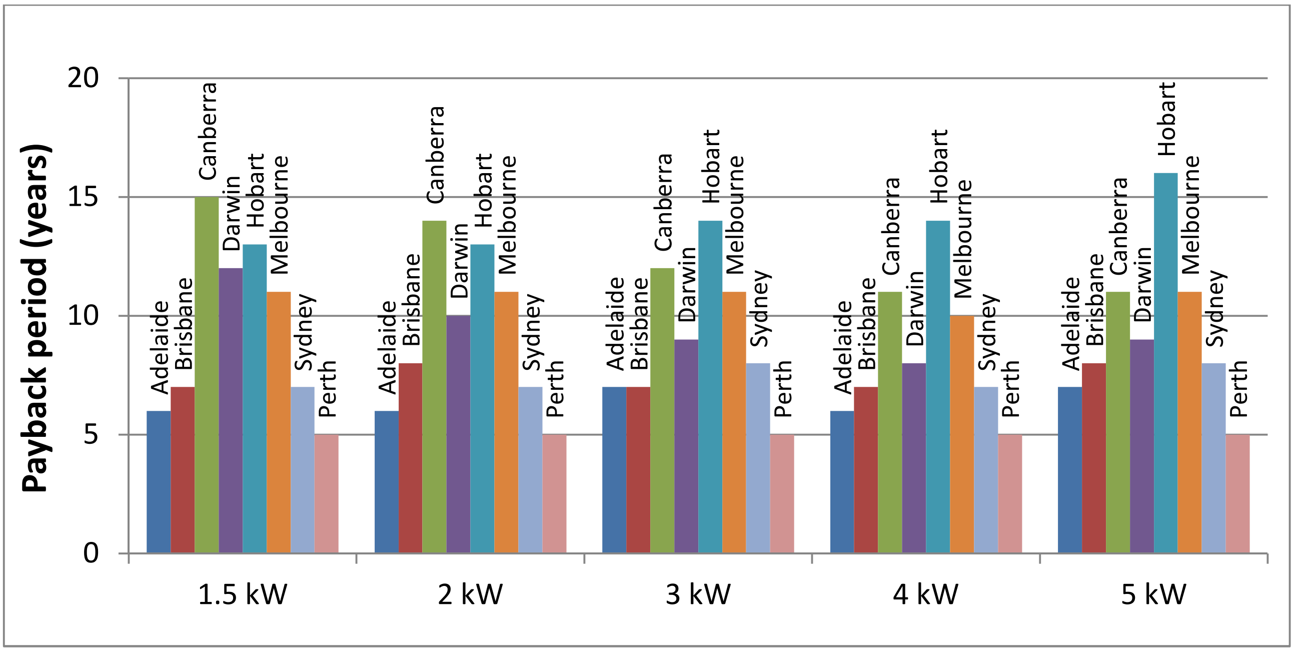
	System Size			
All figures in c/KWh	**10**	**30**	**50**	**100**
Adelaide	$0.12	$0.11	$0.11	$0.11
Brisbane	$0.12	$0.11	$0.11	$0.11
Canberra	$0.12	$0.11	$0.11	$0.10
Melbourne	$0.14	$0.13	$0.13	$0.13
Sydney	$0.13	$0.12	$0.12	$0.12
Perth	$0.11	$0.10	$0.11	$0.11

SECTION VI: 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 at Appendix 2. Since Darwin has the highest FiT in Australia (see tables 1, 2, 3), it leads to a quicker payback period for larger systems due to assumed increases in exports to the grid.

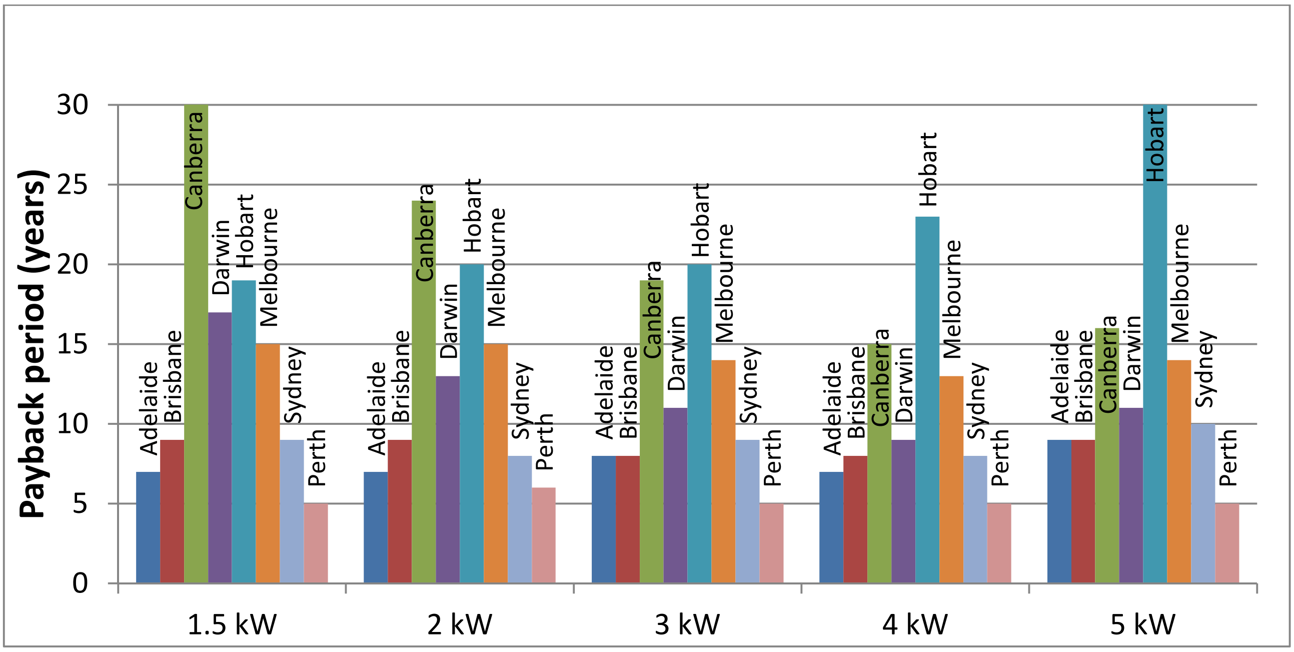
Figure 7 highlights the payback period for different system sizes across Australia. Note that electricity prices are increased at CPI levels and if these prices rise above or below CPI, this will change the payback period.

Figure 7: Payback period for solar PV (5.25 per cent discount rate)



Perth has a constant payback period of 5 years for all different system sizes, while Adelaide, Brisbane and Sydney all have consistently low payback periods of no more than eight years. Payback periods are extremely sensitive to the discount rate applied. Figure 8 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 8: Payback period for solar PV (6.82 per cent discount rate)

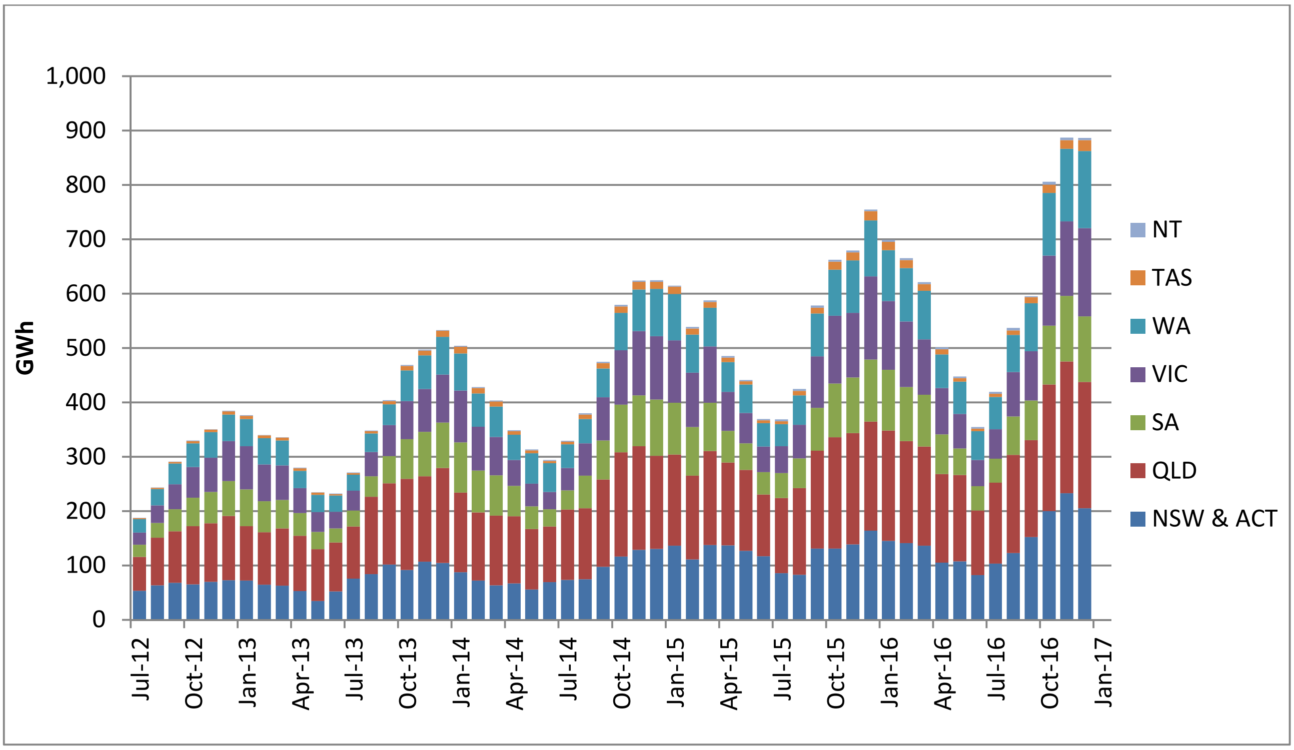


Similarly, under the scenario where customers are buying a solar system with a personal loan where the minimum of the Big Four banks payback rate is currently 14.01 per cent, no payback period is less than 25 years, even in Perth.

SECTION VII: 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.

Figure 10 shows an increasing seasonal pattern, where PV generation is low during May to July, while generation reaches top during summer of each year. December is the month where has been consistently the highest in terms of PV generation.

SECTION VIII: 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 1st 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, 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[xvii], 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 (6.82 per cent).

The low discount rate sensitivity is based on the minimum variable home loan mortgage rate offered by the Big Four banks (currently 5.25 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 5.69 per cent and the small business discount rate is 7.64 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[xviii]. 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 $\sum$ savings > $\sum$ 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

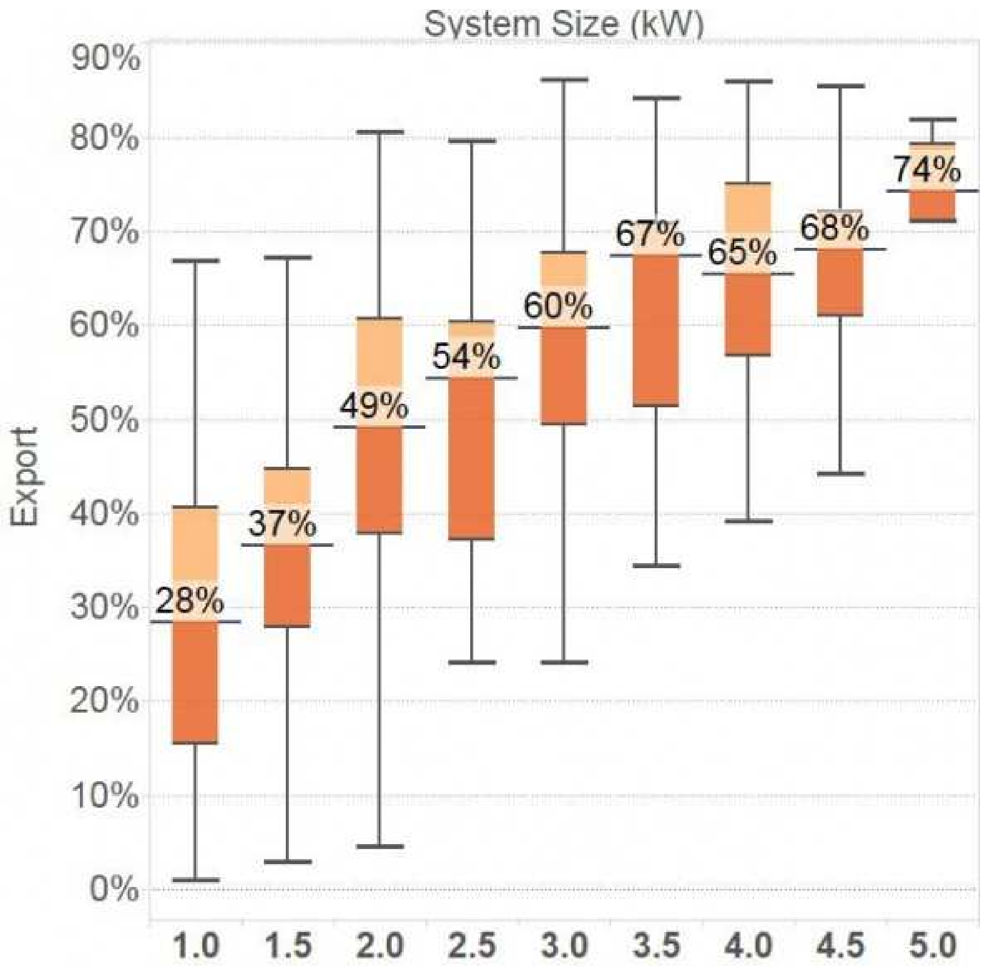
Avoided cost and FiT

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[xix]. See Figure 6 below.

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



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[i] https://energy.gov/eere/sunshot/about-sunshot-initiative
[ii] https://energy.gov/eere/sunshot/about-sunshot-initiative
[iii] http://www.pv-tech.org/news/us-sunshot-initiative-gains-us107-million-for-solar-technology-advancements
[iv] https://energy.gov/eere/sunshot/sunshot-initiative-goals
[v] Solar Market Insight Report 2016 Q4, 2016
[vi] http://www.energymatters.com.au/renewable-news/sunshot-solar-goals-em5752/
[vii] https://energy.gov/eere/sunshot/sunshot-initiative-goals
[viii] http://www.governorswindenergycoalition.org/?p=19694
[ix] https://energy.gov/eere/sunshot/incubator-projects
[x] https://arena.gov.au/funding/
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