Solar PV & Battery Update

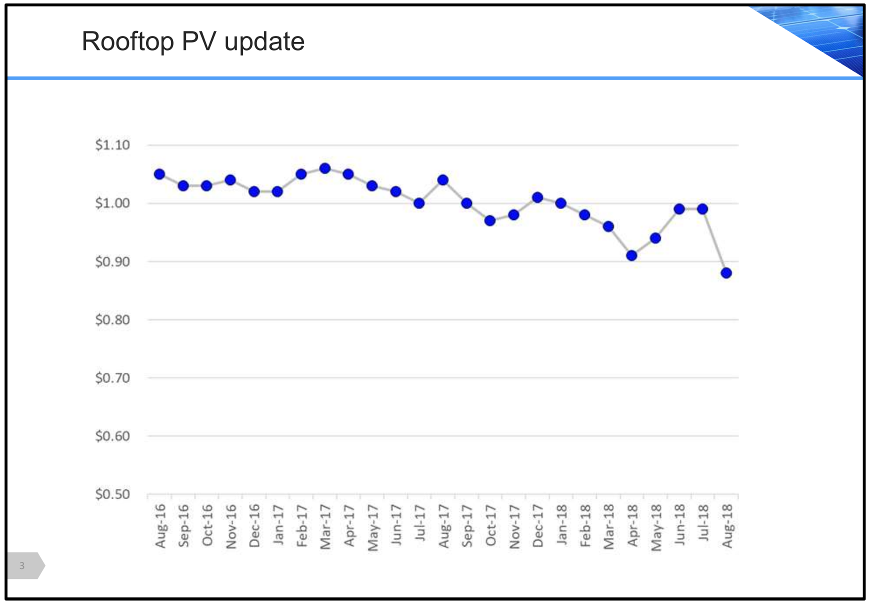
Simon Evans, Beast Solutions

PV update

Battery update

Insights & future developments

2



Prices have dropped below the magic $1/W, previously only available to utility-scale solar developers.

Some flattening of the previously strong downward trend however. The industry is highly competitive, and is starting to reach a floor price determined by labour & equipment costs.

Rooftop PV update

Levelised cost of energy ($/kWh)				
	3 kW	5 kW	7 kW	Grid
Canberra	$0.13	$0.11	$0.12	$0.22
Sydney	$0.13	$0.12	$0.12	$0.31

Lifestyle	Simple payback for a 5kW system	IRR
Absent during the day	5-7 years	16%
Home during the day	3-6 years	20%

Discount rate equal to 10-year average standard mortgage rate (6.53%)

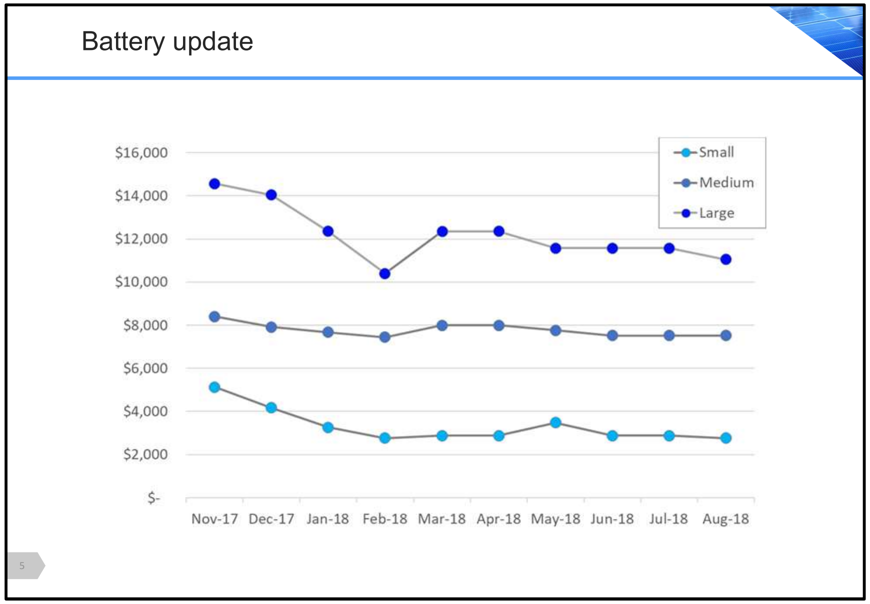
4

Simple price isn't a fair metric, since panels vary in quality and efficiency, as do the inverters etc.

Levelised cost = total cost of ownership, including installation, maintenance, degradation etc.

Grid parity is when levelised cost is the same as grid prices – rooftop PV has well and truly broken this barrier.

Internal rate of return (IRR) is excellent, especially if you are able to find a use for solar power during the middle of the day (battery, hot water generation & storage, pumping, etc.)



Battery costs have fallen to $700-$1000 per kWh, compared to the predicted $400-$600.
(Add $500-$600 to system cost if you need a battery inverter.)

This flattening of the curve is probably due to several “big picture” factors: the rise in uptake has reduced competitiveness; the rumoured big market plays by the likes of Tesla and Sonnen has precipitated a “wait and see” attitude by others; and the prices of raw materials have risen.

Battery update

Levelised cost of storage ($/kWh)			
	7 kW	11 kW	Grid
Li-ion	$0.38–$0.50	$0.32–$0.38	$0.31

	Simple payback
Absent during the day	10-14 years
Home during the day	8-10 years

Discount rate equal to 10-year average standard mortgage rate (6.53%)
Typical battery warranty period 10 years

6

Simple $/kWh is even worse for batteries than for PV: batteries vary widely in depth of discharge, lifetime charge/discharge cycles, warranty etc.

Note this is levelised cost of **storage.** It still costs $0.11 or so to make the energy. So grid parity is still a way off.

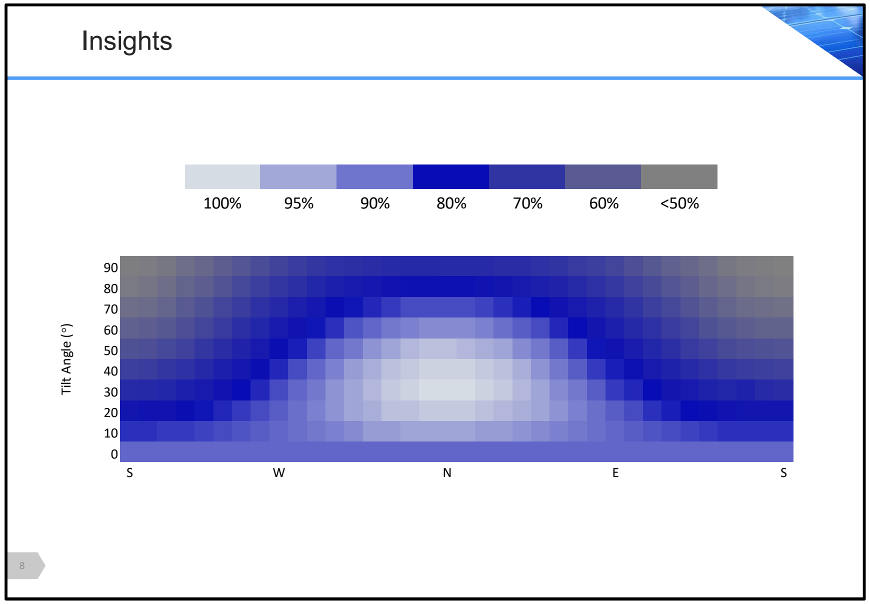
Depending on the particular home, payback period can be (but usually won't be!) close to the magic 7 years that is usually considered reasonable. Generally, however, payback period is longer than the warranty period will typically last (note: battery warranties don't work in years).

Battery update

By	Scenario	Result
CME	Energy efficient home in Adelaide: 5 kW PV & Tesla Powerwall 2	Approximate grid parity
SunWiz (Smart Energy Conference April 2018)	Energy inefficient home in Sydney: 7 kW PV &	ROI 9.4% (PV only 22%)
LG Chem	A home somewhere (?) 5 kW PV & 9.8 kWh LG Chem battery	$0.22 /kWh levelised

Other metrics for batteries can be hard to calculate, different sources use different metrics, and the industry seems to have no clear idea how they currently stand.

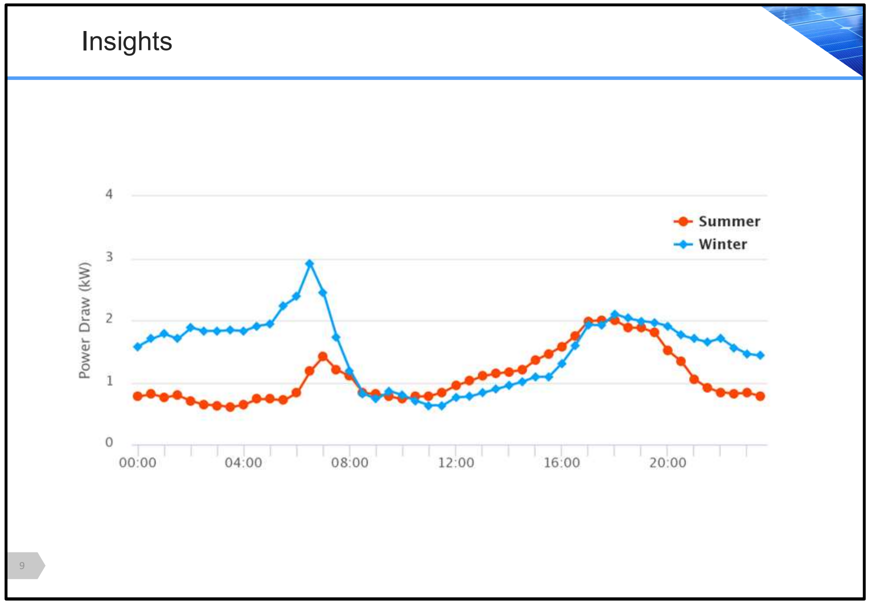
A few recent examples illustrate that the industry is at least starting to approach the level of financial feasibility, usually in very specific cases.



One of the things that still seems to have a hold on people is the idea that panels need to be set up just so. People spend quite a bit of additional money on framing systems to fix panels at the theoretically ideal inclination (equal to latitude) and/or orientation.

This image shows the fraction of potential generation from PV panels set up at various inclinations and orientations. You can get >90% of the system's potential for a wide range of tilt and orientation. There are many other factors that will have at least that much effect on the value you get from the system! (energy usage patterns, cleaning, shading…)

Tip: don't worry about it so much. Or, at today's prices, buy one or two additional panels instead of a framing system to make up the difference.



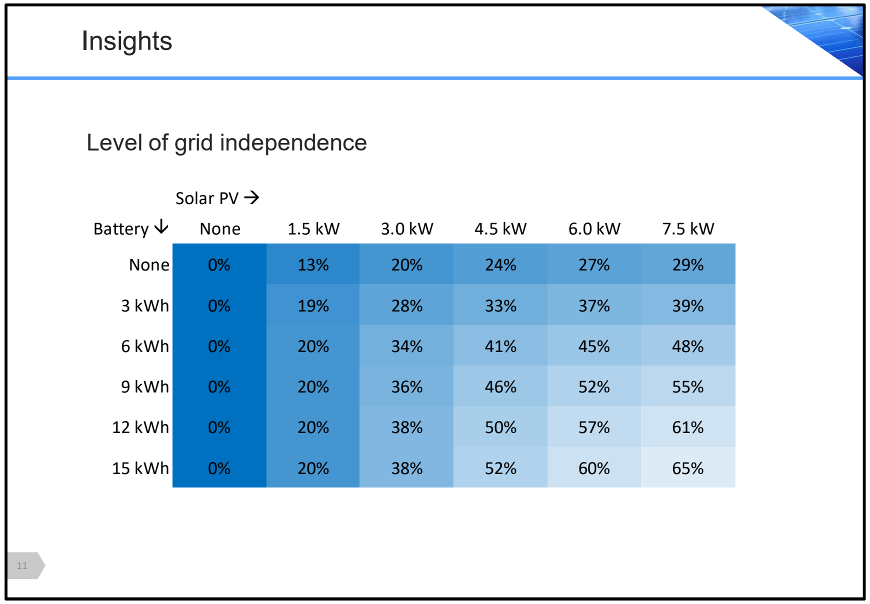
Data from a real (anonymised) home in Canberra.
Typical profile for a home with reverse cycle heating & cooling, residents mostly absent during the day.
Around 30 kWh per day on average (which is fairly high), typical of an older, larger home.

Insights

Total annual cost compared to doing nothing

Battery ↓ \ Solar PV →	None	1.5 kW	3.0 kW	4.5 kW	6.0 kW	7.5 kW
None	100%	96%	87%	80%	75%	72%
3 kWh	117%	111%	100%	93%	88%	85%
6 kWh	128%	121%	109%	101%	95%	91%
9 kWh	142%	135%	122%	112%	105%	101%
12 kWh	147%	140%	127%	116%	108%	103%
15 kWh	158%	152%	139%	126%	118%	113%

Total annual cost impact of various PV/battery combinations for this house
Note best bang for buck is for smaller PV systems of 3-4.5 kW, and smaller batteries 3-6 kWh.
PV “saturation effect”: higher PV generation will mostly go unused.
Batteries can help by soaking up high-value PV energy, but larger batteries are too expensive and smaller batteries fill too quickly.


Insights

Level of grid independence

Battery ↓ / Solar PV →	None	1.5 kW	3.0 kW	4.5 kW	6.0 kW	7.5 kW
None	0%	13%	20%	24%	27%	29%
3 kWh	0%	19%	28%	33%	37%	39%
6 kWh	0%	20%	34%	41%	45%	48%
9 kWh	0%	20%	36%	46%	52%	55%
12 kWh	0%	20%	38%	50%	57%	61%
15 kWh	0%	20%	38%	52%	60%	65%

11

Level of independence from the grid (measured as kWh bought from the grid versus total kWh consumed).

Again, best value for smaller systems [for this home!]

Insights

Tariff numbness

1	Home Electricity Plan
2	Smart Meter Home 25% Offer
3	Smart Meter Home Demand Plan
4	Home TOU Plan
5	Home TOU 25% Offer

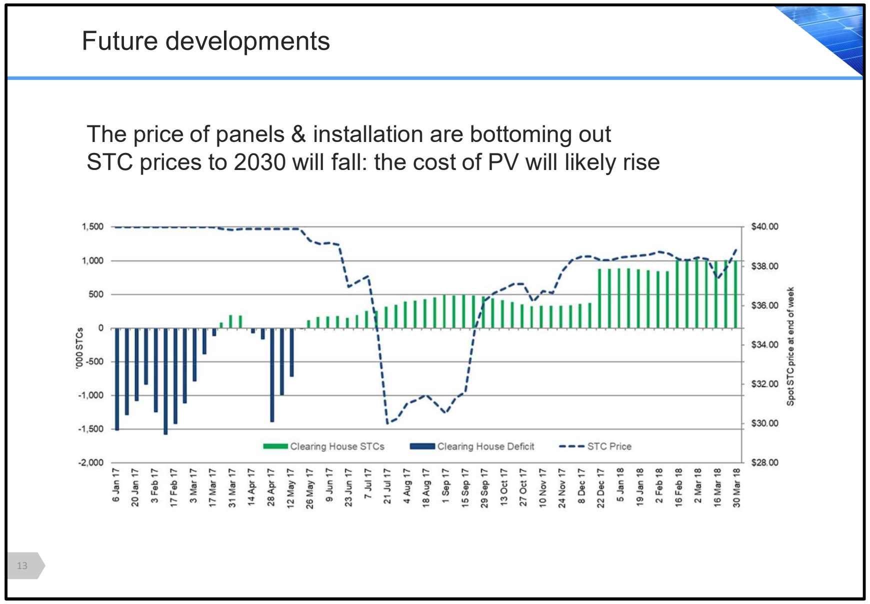
Solar PV →

Battery ↓	None	1.5 kW	3.0 kW	4.5 kW	6.0 kW	7.5 kW
None	**2**	**2**	**2**	**3**	**3**	**3**
3 kWh	**2**	**2**	**5**	**4**	**4**	**4**
6 kWh	**5**	**5**	**5**	**4**	**4**	**4**
9 kWh	**5**	**5**	**5**	**4**	**4**	**4**
12 kWh	**5**	**5**	**5**	**4**	**4**	**4**
15 kWh	**5**	**5**	**5**	**4**	**4**	**4**

This is a very interesting pattern that has become clear in the past few months.

ActewAGL for example: default tariff plan is 1 for new connections, unless you request otherwise. There are many others, typically confusing and hard to judge. Most people don’t bother.

The ideal tariff plan for each combination of PV & battery is shown: the default plan doesn’t appear! Data available to us shows that around 15% of homes with PV and/or battery are on a good tariff structure, and most are still on the default. The potential savings are significant.



Under the RET scheme, the small-scale certificates (STCs) generated at the time you install PV have a significant positive impact on price. But:

(a) The RET scheme ends on 2030, meaning that STCs prices will fall steadily until then

(b) The RET regulator (CER) has consistently underestimated the take-up of PV, causing a surplus of STCs on the market each year, which has to be incorporated into next year's estimates, and so on.

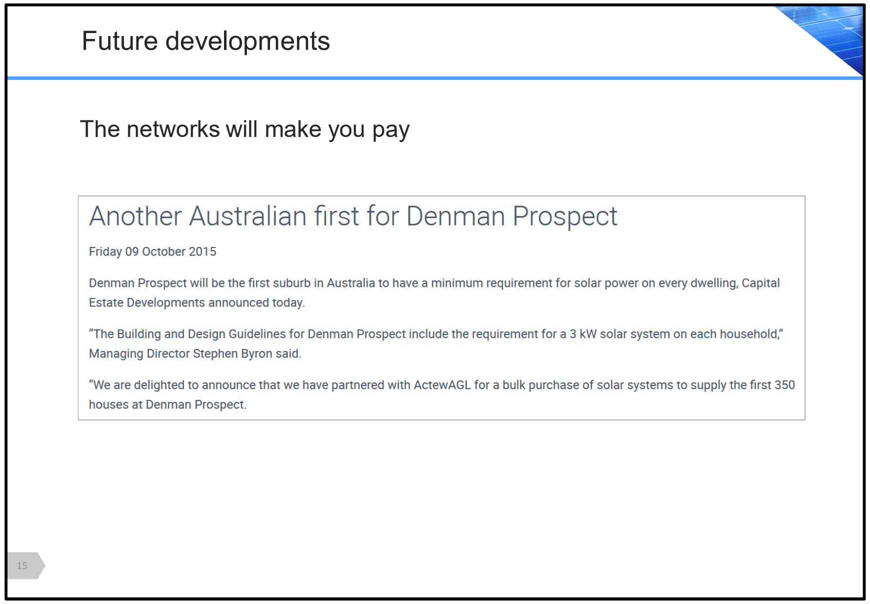
(c) There isn't a lot of fat left in the rest of the supply chain, so STC price falls (both annual crashes and steady decline) are likely to put the brakes on PV price reductions.

Future developments

The price of panels & installation are bottoming out
STC prices to 2030 will fall: the cost of PV will likely rise

…but it's still a good thing to do

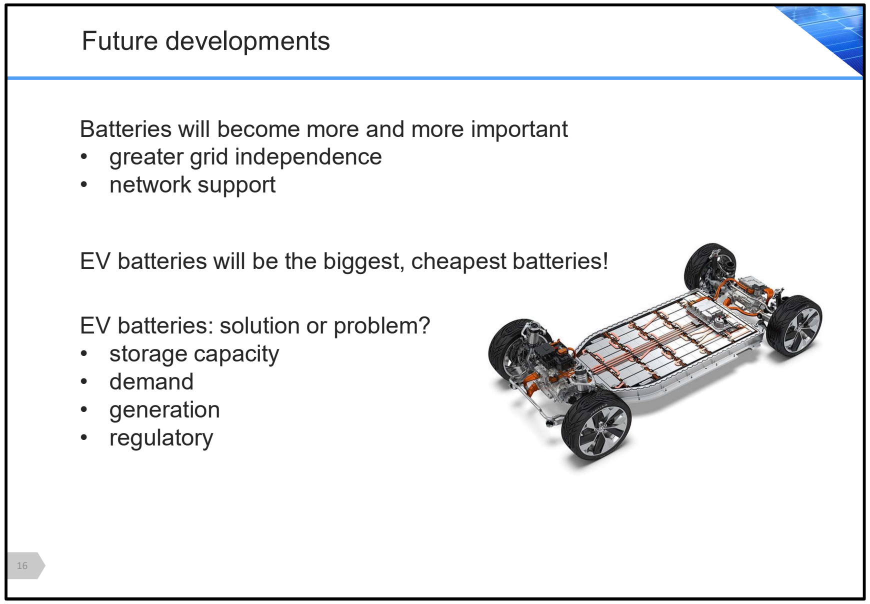
5 kW PV system		
STC market price	**Simple payback**	**IRR**
$30	4 years	20%
$15	6 years	16%
$5	7 years	14%



The distribution network is designed for one-way power flow at a fairly predictable level. There are also strict power quality criteria: voltage range, frequency, reactive power etc. High and growing take-up of PV, increasingly electric homes and the rise of EVs means that power flow, voltage and other factors are increasingly beyond the control of the network utilities, yet they must still deliver reliability and power quality.

In a hypothetical suburb similar to Denman Prospect, this means that the distribution utility would like to (and by national energy law, probably can):

(a) charge the land developer and/or the homeowner for network augmentations such as larger capacity transformers and auto-tap-changing transformers
(b) refuse your PV connection to the grid
(c) switch off or constrain your solar export at will
(d) not pay for solar exports



At least in theory, batteries are a possible cure, acting to control grid demand and as "smoothers" for voltage and power quality.

EVs are the biggest, cheapest batteries. Even a small EV has 3x the capacity of a home battery. The big Teslas have 10x.

Solution or problem?

- storage capacity is huge (good)
- charging at home from PV soaks up high-value energy (good) and reduces reverse power flow issues (good)
- charging at home or work from the grid increases demand (bad)
- potential for grid support is significant (good but complicated)
- connecting to the grid as a possible generator at >30kW is currently difficult from regulatory compliance point of view (bad)
- the networks don't know how to value ancillary services (bad)

Thanks!

simon@beast.solutions