Australian Residential Solar–Storage Analysis – Part 2 – The Prize

(19 Apr 2016) An Independent Expert Analysis of the A$20 Billion Residential Solar–Storage Opportunity Set

Background

Given Australia's significant solar resource coupled with historical feed in tariff incentives, it is not surprising that the country has one of the largest residential solar penetration rates globally. The staggered withdrawal of these incentive tariffs, combined with overall cost deflation has helped catalyse the introduction of customised solar-storage solutions. Whilst Energeia's research has focussed upon the offerings of Tier 1 retailers Origin Energy, AGL Energy and EnergyAustralia, we expect other retailers and technology vendors to join the market over time.

In Part 1 of our Australian Residential Solar Storage Analysis (An Enthusiasts Market) Energeia undertook analysis of the current Tier 1 retailers' solar panel and battery offerings as per Table 1.

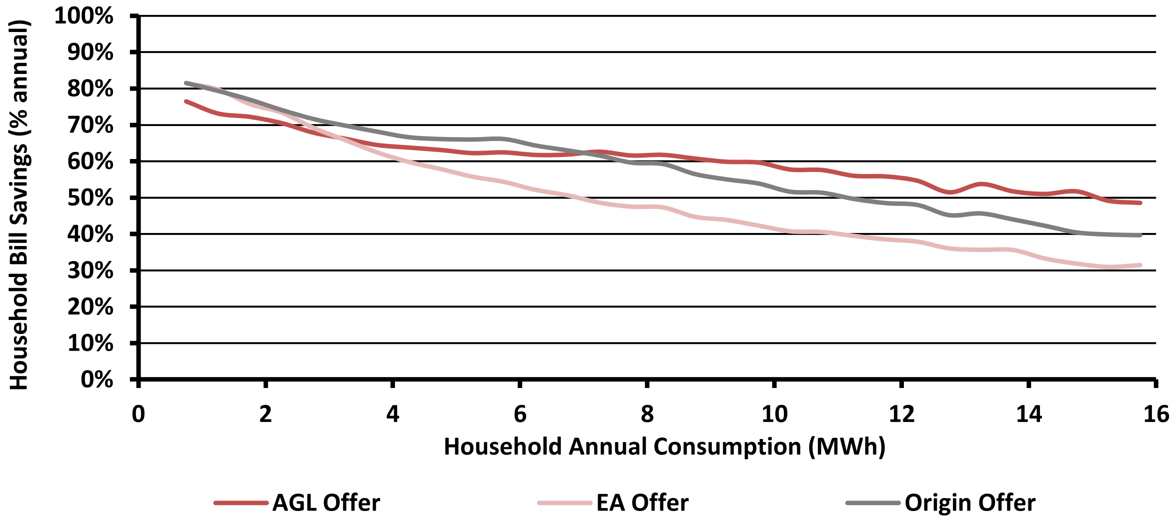
Table 1 – Tier 1 Energy Retailers – Current Residential Solar–Storage Bundle Offerings

Retailer	Battery	Solar System	Indicative Cost ($A)
AGL	7.2kWh Powerlegato Li-ion	Hanwha 3 – 4.5kW System	$13,000 - $14,500
EnergyAustralia[1]	4.8kWh Enphase Li-ion	LG Black 3.1kW System	$11,000
Origin Energy	6.4kWh Tesla Li-ion	Trina 3kW or 4kW System	$15,500-$16,500

Source: Energeia, Company Data

Our analysis concluded that existing market offerings could generate substantial bill savings of 55%-70% for average households (consuming 4.3MWh primary demand per annum). However, for more economically sensitive households these products did not stack up, with <50,000 achieving a positive Net Present Value ($NPV_{10\%}$).

Figure 1 – Bill Savings vs Household Energy Consumption



Source: Energeia

[1] Energeia solution concept based on strategic alliance announced with Enphase, not a commercial offering to date.

Residential Solar Storage Analysis – The Prize

Our Part 1 research identified the poor investment returns of the current solar/storage offerings. Energeia believes that it is inevitable that solar-storage economics will improve and the current vendor/retailer 'arms race' will deliver not only positive NPV outcomes, but attractive investment returns for customers that are sufficiently lucrative to create large household market demand.

This, Part 2, of our research examines the key drivers that will dictate the "size of the prize" for industry participants. In this research, we examine the household economics of adopting a solar-storage system for a range of battery costs, holding all other parameters constant, including the solar panel system price. These economics are examined under two contrasting tariff scenarios, a flat (A$/kWh) tariff and a maximum demand (MD) tariff (A$/kW).

Methodology

Energeia has again used its industry leading Distributed Energy Resource (DER) optimiser to examine the household economics of DER. The DER optimiser takes a tariff, a battery, a solar system and an annual electricity load profile and determines the optimal size of each technology in order to maximise the return on investment for the household. The dispatch plan for the battery is optimised for each 30-minute interval over a 365 day period in order to minimise the household electricity bill.

Each household has a unique electricity usage pattern, even between households of similar demographics and construction, which can strongly influence Return On Investment (ROI) on solar-storage systems. For this reason, Energeia uses a large sample (approximately 10,000 households) of electricity load profiles in order to ensure outcomes representative of the population.

Energeia has chosen to concentrate on a flat tariff structure (the most common household tariff today) and an MD tariff structure (the most positive return for solar-storage households). The MD tariff used in the modelling is based on a tariff structure proposed by a Victorian DNSP (UED) using an LRMC of A$156/kW. The rates were set such that the revenue recovered for the set of households is comparable to the Ausgrid network.

Table 2 – MD Tariff Details

Component	Applies	Special	Unit	Retail Rate ($A)
Monthly Maximum Peak Demand	15:00 - 21:00 on working weekdays (1 Dec – 31 Mar)	Min charge of 1.5 kW	kW	20.32
Monthly Maximum Off-Peak Demand	15:00 – 21:00 on working weekdays (1 Apr – 30 Nov)	Min charge of 1.5 kW	kW	19.33
Metering Charge	All-time		Days	0.14
Energy Charge	All-time		kWh	0.06
Feed-in Tariff	All-time		kWh	0.06

Source: Energeia, UED

Assumptions

- An 8 year or less payback period is attractive for householders
- The payback calculation used is simple (i.e.: no time value of money discounting)
- A fixed installation cost of A$500
- A fixed inverter cost of A$500
- Solar PV system prices are A$1,400/kW installed without inverter
- The inverter size is half the battery capacity, i.e. a 3kW inverter for a 6kWh battery

Results

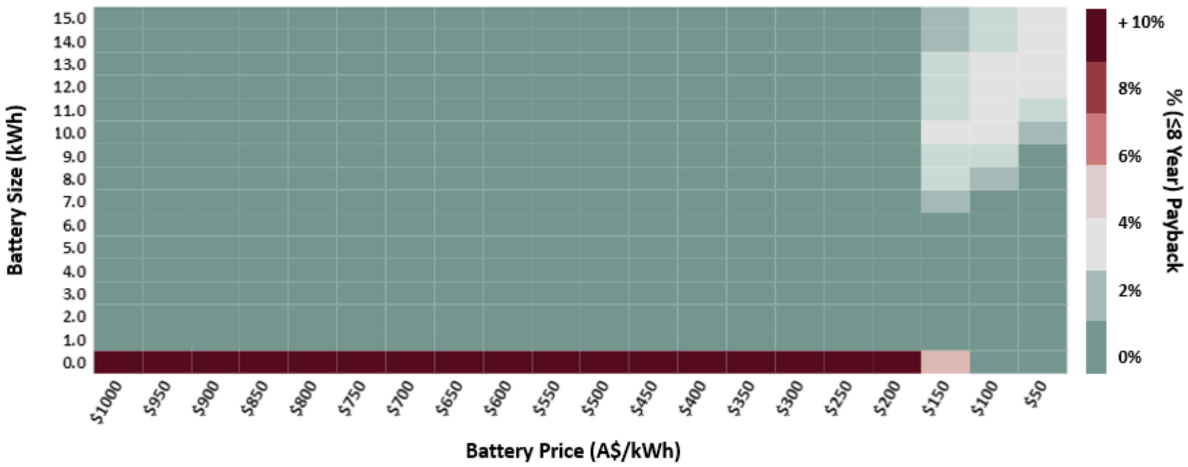
Figure 2 shows the percentage of households with an 8 year or less payback assuming a flat tariff against key variables of battery size (kWh) and battery price (A$/kWh). Note that every column sums to 100% of households. For a given battery price, the 10,000 households are distributed across battery size based on which system offers the most attractive investment, with the colour corresponding to the percentage of total households that have a payback period of 8 years or less.

The red line along the zero battery size row shows that there are no households that are economically better off by investing in a battery system until battery prices fall to the A$150/kWh mark. These households are better off by investing in a solar system only.

For battery prices at or below the A$150/kWh mark, it becomes economically viable for the majority of households to invest in a battery. The optimal battery capacity for these customers falls between 7 kWh and 15 kWh, reflecting the volatility in daily consumption between households.

Under a flat tariff, the only way to generate value from a battery is to store excess power generated by the solar panel in the middle of the day and use it in the evening. This only becomes viable for the household when the levelised cost of storing the energy in the battery falls below the difference between the cost of energy to the customer (~22c/kWh) and the opportunity cost of missing out on the feed-in credit (~6c/kWh). This breakpoint occurs at a battery cost of ~A$150/kWh for the majority of households.

Figure 2 – Flat Tariff Heatmap – Battery Price vs Size providing % (≤ 8 Year) Paybacks



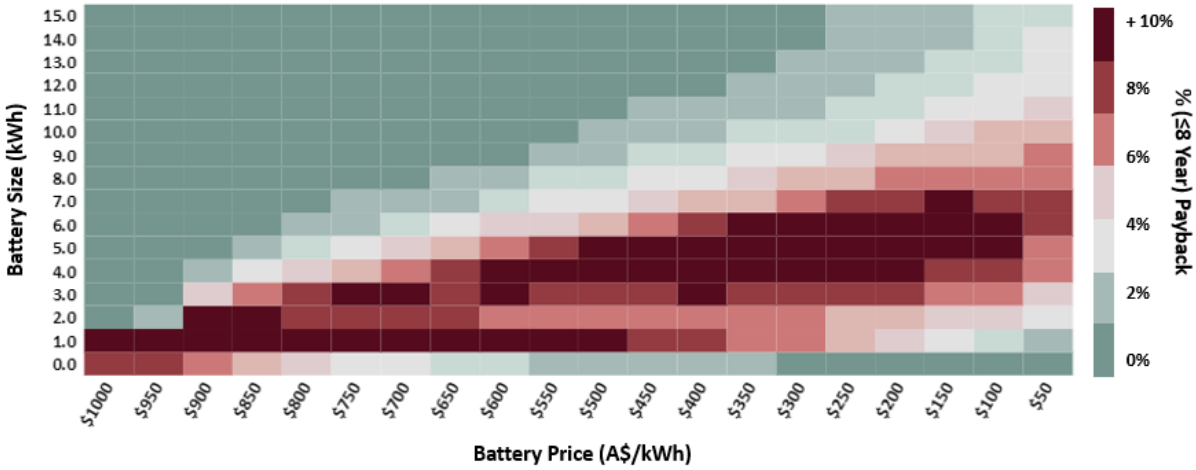
Source: Energeia

Figure 3 shows the percentage of households with an 8 year or less payback under a MD tariff against key variables of battery size (kWh) and battery price (A$/kWh).

The results clearly show that a battery used under a MD tariff provides significantly higher value to the household compared to a flat tariff. This is because the battery can be used effectively to reduce the net maximum demand of the household and therefore reduce the electricity bill. There are three notable features of this heatmap:

- At a battery price of A$1,000/kWh, which is close to today's prices, there is a significant value proposition for a large number of households to adopt a smaller 1 kWh battery
- The red band in the heatmap shows an upwards trend in optimal battery capacity as battery prices deflate. This suggests that each incremental kWh of battery capacity brings less value to the household and it follows that the first kWh is the most valuable
- Battery capacities plateau at around the 5-6 kWh mark, despite the battery price falling below the A$450/kWh mark. This suggests that a 5-6 kWh battery is the optimal size for typical Australian households under an MD tariff.

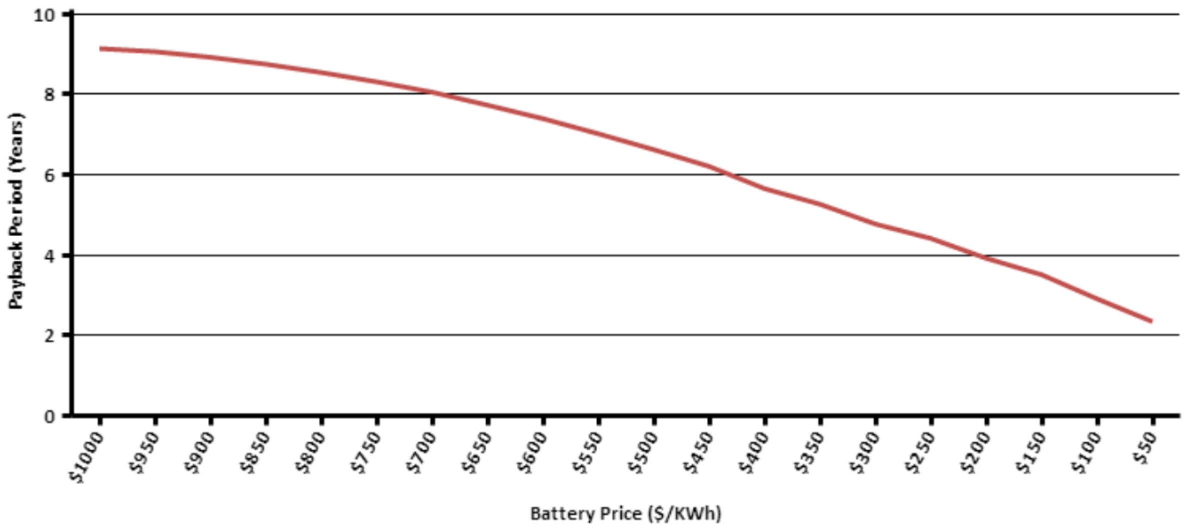
Figure 3 – MD Tariff Heatmap – Battery Price vs Size providing % (≤ 8 Year) Paybacks



Source: Energeia

Figure 4 shows the median payback period against a range of battery prices. Predictably, the payback period improves as battery price falls.

Figure 4 – Payback Period (Years) vs Battery Price Deflation using MD Tariff



Source: Energeia

Market Analysis

In this section we examine the size of the Total Addressable Market (TAM) under the assumption that an MD tariff is offered nationwide. Energeia assumes a TAM of at least 100,000 households is needed to support a competitive market. This market size assumes 5+ incumbents supporting leading market shares of 10,000 – 20,000 installs and associated economies of scale. For large batteries (≥4kWh), this analysis suggests that battery prices will need to "breakthrough" <A$900/kWh to support this size of market.

Today, these economics remain a (not too distant) dream. We consider four possible unit cost scenarios for large size (≥4kWh) batteries; namely:

- Bull Case – A$400/kWh (aspirational)
- Base Case (Energeia 2018 forecast) – A$800/kWh
- Breakthrough – A$900/kWh
- Bear Case – A$1,000/kWh (equivalent to 2016 pricing)

Battery size and total balance of systems costs are held constant across all four scenarios to allow a simple comparison of total installation costs. In reality, the battery size dictates a customised balance of system outcome.

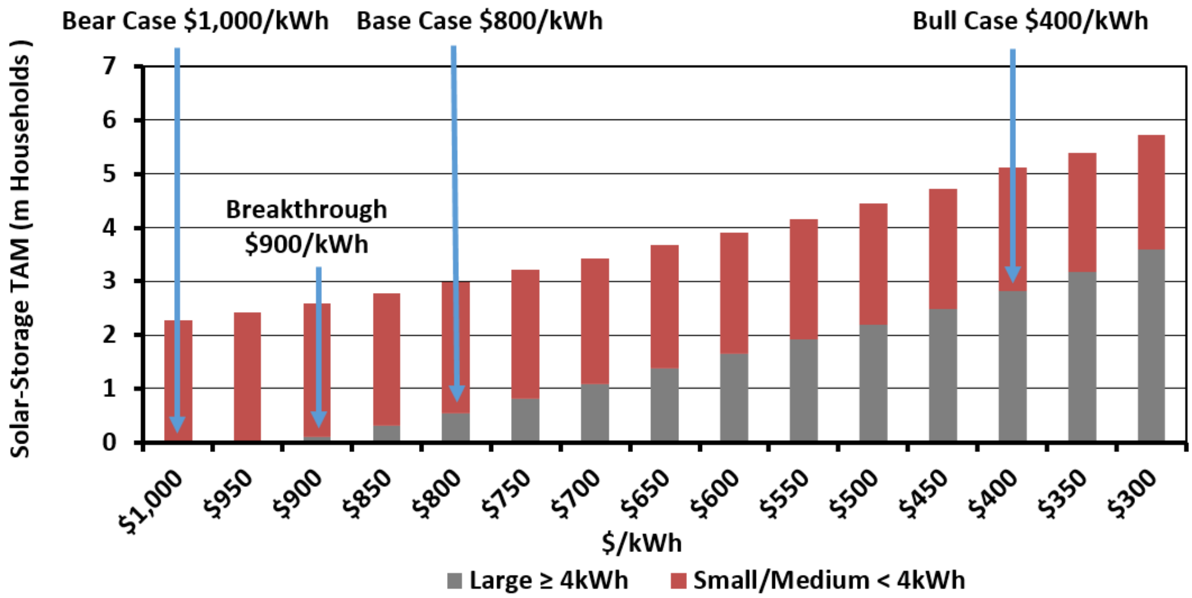
Table 3 – Large Size (≥4kWh) Battery – TAM vs Battery Unit Costs (A$/kWh)

Scenario	Battery Unit Cost (A$/kWh)	Battery Cost (A$)	Balance of System Cost (A$)	Total Cost (A$)	TAM (households)	TAM (A$Bn)
Bull	400	1,600	5,200	6,800	2,820,000	19.2
Base (2018)	800	3,200	5,200	8,400	540,000	4.5
Breakthrough	900	3,600	5,200	8,800	100,000	0.9
Bear	1,000	4,000	5,200	9,200	10,000	0.1

Note: 4kWh batteries and 3kW solar panels assumed
Source: Energeia

Figure 5 shows small/medium (<4kWh) and large battery (≥4kWh) TAM sizes driven by four scenarios of battery unit costs.

Figure 5 – The Prize – A$20Bn Australian Residential Solar–Storage Market – a Lucrative Destination



Source: Energeia

Conclusions

- Energeia believes that economically rational households (early majority) will purchase solar-storage systems when the price supports a ≤ 8 year payback – we are not there yet
- An MD tariff significantly boosts the value a battery provides to households. Networks must set their MD tariffs carefully to avoid introducing a large cross-subsidy between customer groups (much like what has occurred with solar PV)
- Large batteries (≥4kWh):
  - Prices need to fall below a retail (battery only) price of A$900/kWh, assuming MD tariff availability, in order to support a TAM of at least 100,000 households
  - Looking forward, our Energeia (2018) base case (battery only) of A$800/kWh suggests a large battery market size of 540,000 households (equivalent to an A$4.5Bn market)
  - However, should battery makers achieve a step change in manufacturing costs and be able to offer an <A$400kWh (battery only) price, then the size of the prize for large battery makers expands materially to ~2.8 million households (equivalent to an ~A$20Bn market)
- Small/medium batteries (<4kWh):
  - The first kWh of battery capacity delivers the most value. For small/medium solutions there is a significant opportunity today (~2 million households), providing a significant first mover advantage, particularly for the retrofit market
  - The small battery TAM remains resilient (2.5 – 3.0 million households) despite significant battery cost deflation potential, highlighting the economic importance of utilisation and right sizing solutions to maximise customer benefits

About Energeia

Energeia Ltd is an international energy specialist research provider. Our core competencies span the entire Australian electricity sector including its technical, financial and economic operation from behind-the-meter to the wholesale generation market. Our clients include retailers, networks (both distribution and transmission), generators, governments and industry associations seeking services of regulatory review, forecasting of supply and demand, business case development, financial modelling, government program and policy design, and investment strategy.

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