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Distributed Solar with Storage … and Disconnection?

Bridget McIntosh[1]
[1]*Carbon Bridge Pte Ltd Singapore*

E-mail: bmcintosh@carbon-bridge.com

Abstract

Distributed rooftop solar PV is already disrupting the traditional centralised, single direction electricity system in Australia. As the costs of storage come down, solar customers can store excess generation, rather than selling it back to the grid at significantly less than they pay to buy it from the grid at night. Industry analysts such as UBS (Hummel and Lekander, 2013) and Citibank (Channel and Nguyen, 2013) predict storage with solar PV will be applied at large scale once feed in tariffs expire and the costs of battery storage come down.

Distributed storage and solar is an opportunity for distribution network service providers (DNSPs) – it can improve the utilisation of existing networks, delay infrastructure upgrade, manage intermittent renewable energy generators and possibly lower line loses (Vassalo, et al., 2014). However, analysis by Goel (2013) highlighted that DNSPs can miss out on these benefits if they don't work with customers to achieve their needs. Fortunately, many of the US solar storage business innovations are focused on the utility: aggregating distributed solar and storage for grid response, such as Sunverge or SolarCity.

Two key issues could hold back the solar and storage market - electricity tariff structures that act as disincentives for solar and storage (such as fixed network charges); and the lack of transparency and transaction costs associated with supplying ancillary services to DNSPs.

These issues may slow the uptake of solar and storage in the short term, however in the longer term, as the price of storage and solar continues to decrease, disconnecting from the grid becomes attractive. But will customers disconnect from the grid? Economic parity, based on the cost of electricity alone, doesn't necessarily mean disconnection. If DNSPs offer competitive fees and tariffs, the majority of customers will remain connected to take advantage of the cost effective reliability offered by the grid: this may mean that DNSPs may adopt 'shadow pricing' so as to remain just cheaper than the disconnection option to ensure they don't lose customers (Reisz et al., 2014). As highlighted by the Future Grid Forum (CSIRO, 2013) 'the current distribution system would need to change its focus and become a platform and marketplace for local power trading'. This is the New York Public Service Commission 'Reforming the Energy Vision' goal - to reconfigure utility regulation to promote energy efficiency, increase the penetration of renewables and grow distributed energy resources to complement (not replace) the current centralised system (Cameron, 2014).

1. Introduction – Distributed Solar and Storage

Distributed solar energy is now part of the electricity landscape in Australia and this growth is expected to continue - forecasting by Acil Allen Consulting in their analysis for the Renewable Energy Target Review indicate the installed capacity of small scale solar PV will almost triple by 2030, with or without the Renewable Energy Target (Hyslop and Kelp, 2014). This forecast is similar to AEMO's 'moderate uptake' of rooftop PV installed capacity (AEMO, 2012), which is relevant given the 2030 'slow uptake' projections for 2030 are almost already met (Weiss, 2014).

As the costs of storage come down, it will become economic for householders to add storage to absorb their excess daytime generation for use at night, rather than selling it back to the grid at significantly less than they pay to buy it from the grid. That is, if they are paid anything at all, or even allowed to export it (some utilities, such as Ergon Energy in Queensland, block households exporting power to the grid all together (Vorrath, 2014) thereby making solar even less attractive). Low feed-in-tariffs (FiTs) for customers reduces the benefit of exporting excess energy to the grid. Consequently there is little incentive to the customer to install rooftop PV systems that are larger than their daytime load (although it is noted that despite lowering FiTs, solar PV system sizes have increased on average in Australia (IEA, 2013)). This limits the potential for customer-side investment in rooftop PV and since the per kW installed cost is higher for smaller systems this also reduces the economic performance of rooftop solar in general. These effects limit both the size and number of customers who could use solar. Consequently, the priority business case for many households in NSW is that of maximising self-consumption of their solar electricity.

Industry analysts UBS expect solar and storage solutions to be applied at larger scale once solar subsidy schemes run out (Hummel and Lekander, 2013). Citibank consider storage to be the 'inevitable conclusion to the solar boom' (Channel and Nguyen, 2013).

2. The declining costs of storage – what are the economics of adding storage?

According to the USA Department of Energy, lithium-ion batteries for electric vehicle production costs have dropped by 50 percent since 2009 (Tillemann et al., 2013). Investment Advisory firm UBS (Hummel and Lekander, 2013) expect a 10% annual price decline for batteries – they do not attribute this to any technological leaps, but rather "to the start of industrial manufacturing, which should lead to lower unit costs; higher production volumes should improve components purchase conditions, and a more widespread application should decrease margins for sales agent".

The Rocky Mountain Institute (2014) estimated battery price projections based on research from the US Energy Information Administration, Bloomberg New Energy Finance, and Navigant Research, best summarised in Figure 1.

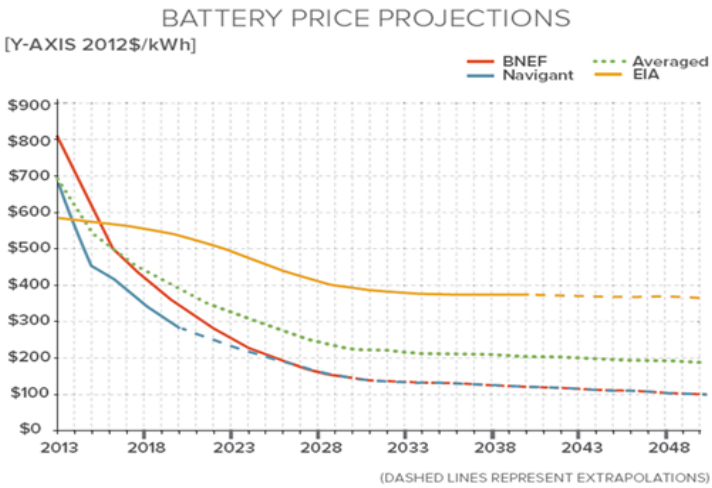

Figure 1. Battery Price Projections (RMI, 2014)

In Australia, storage costs projections have been developed by Marchment Hill Consulting (2012) for the Clean Energy Council and James and Hayward (2012) at CSIRO for AEMO 100% renewable study. The Future Grid Forum summarised this information and took a trajectory that storage costs would halve by 2030.

Goel (2013) conducted analysis on the economics of household solar and storage systems using 2012 costs. The study included a detailed analysis of predicted solar output based on Bureau of Meteorology data and actual customer load profiles from the Endeavour network in NSW with varying tariffs and FiTs. The analysis showed a simple payback of at best 6.5 years up to over 10 years. For many of the customers, the Net Present Value (NPV) of solar and storage was lower than the NPV of solar alone. This is similar to analysis in Germany, highlighted by Markus Hoehner, CEO of the International Battery and Energy Storage Alliance, which shows that the NPV is currently positive for solar PV and storage, however until storage prices drop the NPV with solar without storage is better (Weiss, 2013).

In his presentation as part of the Future Grid Research Cluster Symposium, Tony Vassalo (2014) summarised analysis that indicated at present costs of solar and batteries, the 10 year NPV for smaller sized batteries and larger sized solar systems is positive, however for systems with larger sized storage the NPV is negative. Allen (2014) from Australian solar wholesaler Solar360, claims that an on-grid 5kWp solar PV array and 10kWh of useable stored energy from lithium-ion batteries (total retail cost of $25,000 with GST) have a levelised cost of energy of less than 0.29c/kWh, which is similar to the standard retail rate and much lower than the peak Time of Use (ToU) tariffs in NSW.

CSIRO's customer survey in distributed energy indicated the main driver for customers to install solar systems is to save money on electricity bills (Romanach 2013). As the cost of storage comes down, the addition of storage can help customers further reduce their electricity bills, and help protect against future price rises.

3. What's in it for DNSPs?

Storage added with distributed solar systems can help DNSPs optimise the use of their existing networks and delay future investment. Vassalo et al., (2014) highlighted that residential storage could improve the utilisation of existing networks, delay infrastructure upgrade, manage intermittent renewable energy generators and possibly lower line loses.

Solar PV systems with storage can reduce daily and annual demand and generation peaks in network areas by storing daytime solar production locally for dispatch during peak times. Goel (2013) highlighted that if DNSPs actively participate in the implementation of storage with solar and incentivise customers (eg influence system size and discharge time of the day) the systems can help meet network objectives. If DNSPs don't participate, then customers will go ahead and install systems that meet their own needs and may not necessarily support DNSPs achieve their objectives. The study concluded that systems optimised to meet DNSP needs resulted in a net 23% peak load reduction. For household systems not incentivised (ie they choose the size and discharge times to suit their needs) net peak load reduction was only 4.6%, with little value-added contribution from storage.

The idea that solar and storage can help optimise network investment is why New Zealand utility Vector Ltd launched a solar and storage leasing package for customers. Vector offer a 3kW array with inverter and 10.7kWh lithium ion battery to benefit both themselves as the utility in terms of peak demand management as well as making it affordable to customer by avoiding the upfront cost (Parkinson, 2013).

In addition, distributed solar and storage can also help manage some of the power quality and safety issues arising from high penetration PV in the local network area; and help manage distribution costs and the issues arising from high renewables penetration on the grid's fringe.

However, a survey of DNSP responses to the technical issues posed by high penetration PV on their networks found that most DNSPs do not plan to use storage to solve this problem,

preferring instead to focus on regulation of PV deployment, such as limiting system size, rather than solutions incorporating storage (Noone et al., 2013). Indeed the two Queensland DNSPs have introduced new standards that will require any rooftop solar system under 30kW to have equipment installed that can limit export to the grid (Vorrath, 2014).

4. Solar and Storage Market – what's on offer now?

A number of companies are developing products and innovative business models that have the potential to bring benefit to both DNSPs and customers. Many of the US solar storage business models are focused on the utility: aggregating distributed solar and storage for grid response, such as Sunverge or SolarCity. Sunverge's business model is based around building and managing customer energy-storage systems as utility assets (Sunverge, 2014). Their technology focuses on distributed solar and storage with cloud based controls to allow aggregated electricity to be controllable and dispatchable – so it benefits both households and network operators (Lacey, 2014). Sunverge are expanding their services and are looking to participate in the storage and solar market in Australia with the intention of working with DNSPs to aggregate benefits to them from storage. ARENA has recently funded Sunverge and Ecoult to support them to develop and enter the distributed solar storage market in Australia (ARENA, 2013 & 2014). Australian start-ups such as Reposit Power and Switchdin are developing products that enable better integration and control of distributed storage. Companies, such as Dutch Vandebron, are also developing innovative products to enable electricity customers to participate in the peer to peer (P2P) sharing economy. Their platform facilitates individuals to buy excess solar or biogas production directly from local farmers (Crosby, 2014).

Solar leasing models are rapidly being deployed in Australia after Sungevity began offering their leasing model in 2012 (Blanch, 2014). The Clean Energy Finance Corporation recently announced funding of $120m to expand the range of financing options in Australia (including leasing and PPAs) through Sun Edison, Tindo Solar and Kudos Energy (CEFC, 2014). These leasing and financing packages simplify the customer offering and are likely to be a key channel for promoting the uptake of storage systems when the costs come down.

The packaging of solar, storage or controls is already available in Australia, such as the German Bosch or Chinese BYD packages, Samsung SDI All in One solar storage system, or the ZEN Freedom PowerBank Energy Storage System. Inverter manufacturers are also focussing on hybrid Inverters with storage. Selectronics, Australia's own hybrid inverter, have reported strong sales in recent years in Australia (Scott, 2014). SMA launched their SMA Sunny Boy Smart Energy hybrid inverter in July 2014.

The solar and storage market in Australia is gearing up for anticipated demand from households and businesses installing storage with their solar systems. An informal survey of 32 solar suppliers in 2012 and again of 8 suppliers in 2014 reported a robust increase in enquiries about storage, with estimates of between 10-15% of new customer enquiries concerning grid connected PV involve strong interest in battery systems (Mears, 2014). This is consistent with claims from solar distributor Solar360's Michael Anthony, who says between 15-20% of solar customers are asking about storage (Parkinson, 2014a).

It is likely solar enthusiasts will start as early adopters, with a new wave driven by NSW Solar Bonus customers rolling off their generous feed in tariffs at the end of 2015. Many Solar Bonus customers have oversized systems geared towards exporting power to take advantage of the generous feed in tariff and will be reticent to sell excess power at low or zero feed-in rates. They may choose to turn to storage to maximise self-consumption and maximise their return on their solar investment. This wave of customers will provide valuable lessons and

help the industry develop product offerings and interactions with DNSPs. International industry development will also bring valuable experience for Australian businesses, particularly from Germany, California and Japan where subsidies for residential storage are available.

5. What may hold solar and storage back?

There are a number of issues that may slow the innovation and uptake of solar and storage. The two key issues are:

- electricity tariff structures that act as a disincentive for solar and storage, such as fixed network charges - these types of charges make solar, solar and storage and any demand management/energy efficiency activity less economic as they cannot reduce the fixed component of the bill. In the short term, this may help DNSPs recoup their investment costs from customers, but will do little to address peak demand, so in the long-term this may require greater investment to address rising peak demand; and,
- the lack of transparency and transaction costs associated with supplying ancillary services to DNSPs - even though storage can provide a variety of benefits to the DNSPs (such as avoidance of network augmentation or improving power quality issues from high penetration PV) at present these are difficult to price and as there is no distribution level marketplace, they are arranged on a case-by-case basis. A more transparent and flexible market mechanism for these services could stimulate new players, investment and innovation.

These issues may slow the uptake of solar and storage in the short term, however in the longer term, as the price of storage and solar continues to decrease, disconnecting from the grid becomes attractive and gives consumers choice against network monopoly. Analysis by UBS of the Australian market predicts disconnection could become economic by 2018 (Parkinson, 2014). Modelling for the Future Grid Forum expects disconnecting from the grid via the use of solar PV, storage and small diesel gensets will become economic by 2030, although they acknowledge their estimates may be out by 10 years. The Rocky Mountain Institute's 'Economics of Grid Defection' report indicates disconnection parity could be achieved in Honolulu, Hawaii by 2022 and Los Angeles, California by 2037 (RMI, 2014). They also modelled the costs of disconnection combined with demand side management improvements (which reduces the size of batteries required and hence the total system cost), reducing the time to achieve disconnection parity by 5-7 years.

The Future Grid Forum (2013) modelled a 'Leaving the Grid' scenario where utilities do not make efforts to address peak demand growth, with subsequent declining network utilisation causes retail prices to increase. This leads to the emergence of new energy service companies offering to help customers to go off the grid, and the modelling suggests that by 2050, almost a third of customers disconnect.

6. Will customers really disconnect?

If the lowest cost way to supply reliable electricity to consumers remains the grid, then people are unlikely to disconnect. Economic parity doesn't necessarily mean consumers will adopt it –going off-grid is not without inconveniences as stand-alone PV/storage systems will have hard limits on their capacity which may be breached from time to time unless demand is managed carefully by the customer. And as Tim Sonnreich from the Clean Energy Council argued at Clean Energy Week 2014, most customers are lazy and unlikely to go off grid. He argued that customers already make conservative choices of their electricity provider and

rarely change providers and it is likely to be the same way for going off-grid (Sonnreich, 2014).

Consequently, Reisz et al., (2014) argue that if DNSPs provide competitive connection fees, the majority of customers would rather remain connected to take advantage of cost effective reliability offered by the grid. DNSPs may adopt 'shadow pricing' of the disconnected option – i.e. remain slightly cheaper than the disconnection option to ensure they don't lose their customers all together. This "acknowledges that full cost recovery of the existing network may no longer be possible in this scenario, but seeks to utilize the existing infrastructure to the maximum benefit of consumers and recover as much of the sunk cost as possible". Similarly Garnaut (2014) argued that centralised network suppliers would need to meet the competitive challenge of disconnection by 'minimising costs and increasing the advantages of using the grid as a complement to decentralised supply of power'.

The Future Grid Forum (2013) suggests 'the current distribution system would need to change its focus and become a platform and marketplace for local power trading' if large numbers of solar storage customers use the grid only for back-up power and to export their own power. This is exactly what the New York Public Service Commission are preparing for with their 'Reforming the Energy Vision' goal to reconfigure utility regulation to promote energy efficiency, increase the penetration of renewables and grow distributed energy resources to complement (not replace) the current centralised system (Cameron, 2014). Sioshansi (2014) argues that these market reforms were initiated because the regulators realised the problem facing the industry they regulate is not limited to the treatment of solar versus non-solar customers, or fixed versus variable charges, or time-variable tariffs, or special tariffs for customers with or without Electric Vehicles, or storage, or any combination of these. The problem lies in the fact that the nature and definition of services that customers desire and are willing to pay for changes – just as happened with mobile telephony, digital cameras, or any other disruptive technologies. "These changes will mean consumers will take advantage of opportunities to generate, store and trade electrons, not just back and forth to the "utility" as is the case today, but to their neighbours across the street, or across the city, or state. Over time, flow patterns that used to be one-way and highly predictable will become complex and convoluted." (Sioshansi, 2014)

The Rocky Mountain Institute, through their electricity innovation labs, is bringing together utilities to engage on establishing the path forward in a changing technological environment as put by John Kreyts: "to create a thriving grid that enables more transactions around the many relationships that will develop with customers, many different suppliers, customers and shifting roles" (Lacey, S, 2014). RMI's goal by 2050, is "to create an electricity system powered predominantly by efficiency and renewables. Where renewable energy and distributed resources can compete fairly, utilities see these resources as opportunities rather than adversaries, and customers can better choose how they use and produce energy" (RMI, 2014).

In Australia, the Power of Choice Review, the Clean Energy Council's "Electricity Distribution Future Proofing" collaborative project, the CSIRO Future Grid Research Cluster and the CRC for Low Carbon Living Distributed Energy Storage scoping study are all opportunities to develop and advance market reforms to encourage the development of a thriving grid.

Until then, it's little wonder Garnaut (2014) argues that the sale of Government-owned network assets should be delayed until fundamental reform of network pricing systems are established.

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