The Energy Project Pty Ltd for SACOSS

Research Report:

How can Community-Scale Batteries lower energy costs for vulnerable customers?

07 July 2020

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Who is The Energy Project?

The Energy Project Pty Ltd is a specialist energy consultancy founded to help clients identify and deliver high quality energy projects.

Our Mission is to maximise the contribution of distributed energy resources to resolving the energy trilemma of reliability, affordability and sustainability.

We provide clients with a unique combination of rigorous technical, regulatory and economic analysis, commercial nous and project management expertise to ensure projects are successfully implemented.

We are fiercely independent and have no affiliations, partnerships or commission arrangements with any suppliers. We work in the best interests of our clients on a fee for service basis.

We work with:

- Clients seeking to procure solar, batteries, LED lighting upgrades, EV chargers and other distributed energy resources with independent technical and tendering advice
- Businesses with flexible demand or flexible exports to get a fair deal from energy retailers
- Owners of Embedded Networks and Microgrids by providing independent compliance, governance and procurement advice
- State Government Agencies to design and implement cost effective energy programs for households and businesses
- The community sector on energy and equity projects
- Electricity Distribution Networks on the challenges and opportunities of integrating distributed energy resources

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Who is SACOSS?

The South Australian Council of Social Service (SACOSS) is the peak non-government representative body for the health and community services sector in South Australia. SACOSS believes in justice, opportunity and shared wealth for all South Australians, and has a strong membership base representing a broad range of interests. SACOSS' core activities include analysing policy and advocating on behalf of vulnerable and disadvantaged South Australians; providing independent information and commentary; and assisting the ongoing development of the health and community services sector.

www.sacoss.org.au

Contents

1 Executive Summary

This work has been commissioned during a period of significant Australia-wide interest and activity in relation to community-scale batteries: battery energy storage connected to the electricity network at the local transformer level and serving dozens or a few hundred customers rather than an individual energy user's 'behind the meter' battery.

This research did not aim to assess the viability of such projects in general but instead considers how this can become an opportunity for renters, and other vulnerable customers to lower their energy costs. The aim of this research project was to:

> *Understand under what economic and governance models community scale batteries may assist low income households to reduce electricity expenditure in rental or social housing settings, as well as assistance for communities rebuilding post bushfires.*

1.1 Findings

Battery Energy Storage Systems (BESS) can provide significant benefits to individual customers, electricity networks and the wholesale electricity market. However, batteries are expensive and degrade with use. Their lifetime of, typically, 10-15 years is significantly shorter than most other electricity infrastructure (25+ years).

With an installed cost of around $10,000[1] the guaranteed energy throughput of a Tesla Powerwall home battery of around 37,000 kWh equates to an equivalent cost of over $0.25 for each kWh that is cycled through the battery (or more if the money to buy the battery was borrowed and interest is included). The implication being that the difference in cost between the energy used to charge the battery and that avoided by discharging must be at least $0.25 per kWh to be an economic proposition.

At today's prices, to be economic at any scale in the electricity market, a BESS must do more than just store excess solar for later use. Other potential benefits from BESS include:

- Allowing more rooftop solar on the distribution network before technical constraints appear – or "increasing hosting capacity" in industry language.
- Rapidly injecting or absorbing power from the network to help manage system frequency around the required 50 Hertz.
- Providing "back-up" power to individual customers or local networks.

[1] See the Home Battery Scheme System Price Guide at https://homebatteryscheme.sa.gov.au/system/files/documents/System-Price-Guide.pdf

Aggregating the various benefits is referred to as the *"value stack challenge"* and a variety of ownership and governance models are being canvassed in recent and current analyses to understand how best to 'realise' this potential value.

South Australia, uniquely in the NEM, is also home to several operating virtual power plants (VPPs) that orchestrate hundreds (and potentially thousands) of individual 'behind the meter' batteries. The Tesla VPP successfully participated in the NEM's Frequency Control markets in 2019-20 and was the first to tackle this vital part of the 'value stack challenge' at the community scale. However, progress on the 'value stack challenge' does not automatically mean benefits for the consumers of interest in this report. These customers can hope to benefit *directly* by accessing a battery to lower their own total electricity costs OR *indirectly* as the uptake of batteries lowers overall electricity system costs and market forces or regulation ensures this benefits all consumers.

In terms of *direct* benefits, most community-scale battery initiatives consider 'storage as a service' for households that export their excess solar power to the grid for their later use – effectively re-using a customer's own excess solar rather than importing energy from other generators when their solar panels can't meet their demand. However, households with solar are arguably much less vulnerable to electricity costs than the consumers of most interest for this report (renters without solar, either in private rental, social or public housing). For these, households the direct benefits are difficult to realise.

The NEM regulatory framework allows for private 'embedded networks' (also known as 'inset networks' in South Australia) to be created that allow multiple electricity customers to connect to the distribution network through a single, shared connection. This could allow for a shared BESS and/or shared solar to lower cost for these households directly. Embedded networks are known to be cost-effective in medium to high density developments. Governance options dictate the consumer benefits of these arrangements and while many apartment dwellers and caravan park residents have reported negative experiences with these arrangements – being 'stuck' on high tariffs with no real choice of retailer - this does not have to be the case. Under different management, the exact same physical configuration of an embedded network can become the 'solar/battery microgrid' imagined by some as a vision of the future electricity market.

Communities rebuilding after bushfires or other disasters offer different opportunities: batteries can substitute directly for other infrastructure costs. The Australian Energy Market Commission (AEMC) has recently approved a rule change that will support 'Stand Alone Power Systems' (SAPS) being used by SA Power Networks (and other regulated electricity distributors around Australia) to deliver electricity to communities that are at the edges of the grid or in high bushfire risk areas. These are important reforms that may create opportunities for community scale batteries either as part of creating a SAPS, or in anticipation of a transition from grid supply to a SAPS.

Without solar, our analysis suggests that the most practical opportunities to directly lower costs for renters is through accessing cost reflective tariffs and shifting consumption to lower cost times rather than hoping to participate in a VPP or accessing a shared battery over the grid. SA Power Networks will soon charge electricity retailers lower rates for use of its residential networks during solar hours – referred to as a "solar sponge" tariff. Wholesale energy prices in South Australia are also trending lower during these "solar hours". Combined, this reflects that the lowest cost electricity will be that available in the daytime and during the "solar sponge" timing of 10AM to 3PM in particular. The trends in solar uptake suggest that this is likely to become even more pronounced in coming years.

If this price signal was to reach households it would provide a clear financial incentive for more energy consumption during the day and the shifting of loads such as water heating from other times. In effect it encourages non-solar customers to 'soak up' the excess solar from their neighbours when it is produced rather than seeing it stored in batteries for later use. Recent proposals from the SA Government to mandate the offering of 'time-of-use' tariffs to households by September 2020 and to reform the state's Retailer Energy Efficiency Scheme (REES) into a Retailer Energy Productivity Scheme (REPS) from 1 January 2021 are critical steps to achieving this potential.

Households would likely need additional support to realise these benefits, but the potential is there to focus on those most vulnerable to meet their energy needs at much lower cost than today. Recent research by Energy Consumers Australia for their Power Shift program highlights the opportunities for targeted information and support campaigns to complement these financial incentives and overcome barriers to change.

1.2 Recommendations

Based on the information reviewed and analysis presented in this report, it is recommended that SACOSS make the following recommendations to the South Australian Government.

Recommendation 1: Transition to standalone supply

Consideration be given to trialling community scale batteries in the context of communities recovering from bushfires, in high bushfire risk areas and at the very edges of the grid that might one-day be most efficiently and effectively served by going 'off grid'. One or more community scale shared battery could be an effective tool in the transition to such a solution.

Recommendation 2: Embedded Network Pilot project

Consideration be given to demonstrating the potential of a medium to high density community housing development using shared solar and storage in an embedded network to lower the overall cost of energy to residents. There is a notable gap in the research reviewed around contrasting community scale batteries with VPP options and such a trial would complement the lessons being learned from South Australia's Home Battery Scheme and related VPPs.

Recommendation 3: Support SA Government Initiatives to introduce Time-of use pricing

Wholesale market price trends and regulated network tariffs are delivering electricity to retailers during the middle of the day that is significantly cheaper than what a simple flat rate tariff would reflect. As a complement to considering batteries, a case exists to ensure that vulnerable customers can access this cheaper electricity if it delivers overall lower costs. It is therefore recommended that SACOSS support the proposed mandating of a Time-of-use (TOU) retail standing offer for all retailers in South Australia and support the realigning of the REES to REPS – a scheme that recognises the benefits of measures that reflect the time of day that electricity is used.

Recommendation 4: Retail electricity offer and other complementary measures for renters

Mandatory TOU standing offers are a welcome start but competitive market offers must follow. Like the South Australian Concession Energy Discount Offer (SACEDO), there is a case for a government sponsored retail time of use market offer for those who would benefit. This would need complementary measures (such as education and other support) to ensure the potential benefits are realised. It is recommended that SACOSS advocate for a package of measures that would see the SA Government initiatives targeted at the consumers of interest for this report.

2 Introduction

Community-scale batteries - connected to the electricity network at the local transformer level and serving dozens or a few hundred customers rather than an individual energy user's 'behind the meter' battery are being recognised as providing significant benefits to electricity systems. The Australian Renewable Energy Agency (ARENA) engaged consulting firm AECOM to explore the pros and cons of deploying battery storage at different points in the electricity network. The recently published report "Grid vs Garage" found that both grid and garage batteries offer benefits for the electricity market and owners, but that positioning them on the low voltage network was the most effective option[2].

Trial projects are operating in Western Australia where the distribution and retailing of electricity to households is still state-owned and not open to competition between retailers[3]. There is evidence of lower overall costs and increased 'hosting capacity' for rooftop solar, leading to much interest in whether these initiatives can be replicated in the competitive and more complex east coast National Electrical Market. Stakeholders are engaged in social, technical, economic, regulatory and philosophical discussions on the role of community batteries in the evolving electricity system.

A case is being made that 'community scale' batteries represent the 'sweet spot' of scale for maximising value to the system (compared to the individual customer scale or the transmission connected 'utility scale' like Hornsdale Power Reserve, aka the Tesla Big Battery).

South Australia represents an important context for such batteries. With relatively high electricity prices, very high penetration of solar and strong Government support for batteries through the popular Home Battery Scheme, it is plausible that such a battery could be viable in SA.

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2 See https://arena.gov.au/blog/is-big-better-when-it-comes-to-batteries/ and https://arena.gov.au/knowledge-bank/grid-vs-garage/

3 Image from Western Power of a 'Powerbank' installation, 2020 https://westernpower.com.au/our-energy-evolution/projects-and-trials/powerbank-community-battery-storage/

2.1 What is a community-scale battery?

There is no agreed definition but an important distinction to be made is the difference between a *community-scale* battery and a *community-owned* battery. For this report we have considered 'shared' batteries connected to the distribution network but under a range of governance and ownership models – of which, community ownership is one of several options.

'Community scale' refers to the energy capacity of the battery and its location on the grid. These batteries are connected to the electricity network at the local transformer level and, in the Western Power examples, have been installed in locations where the local transformer was approaching capacity and the PowerBank has deferred an upgrade.

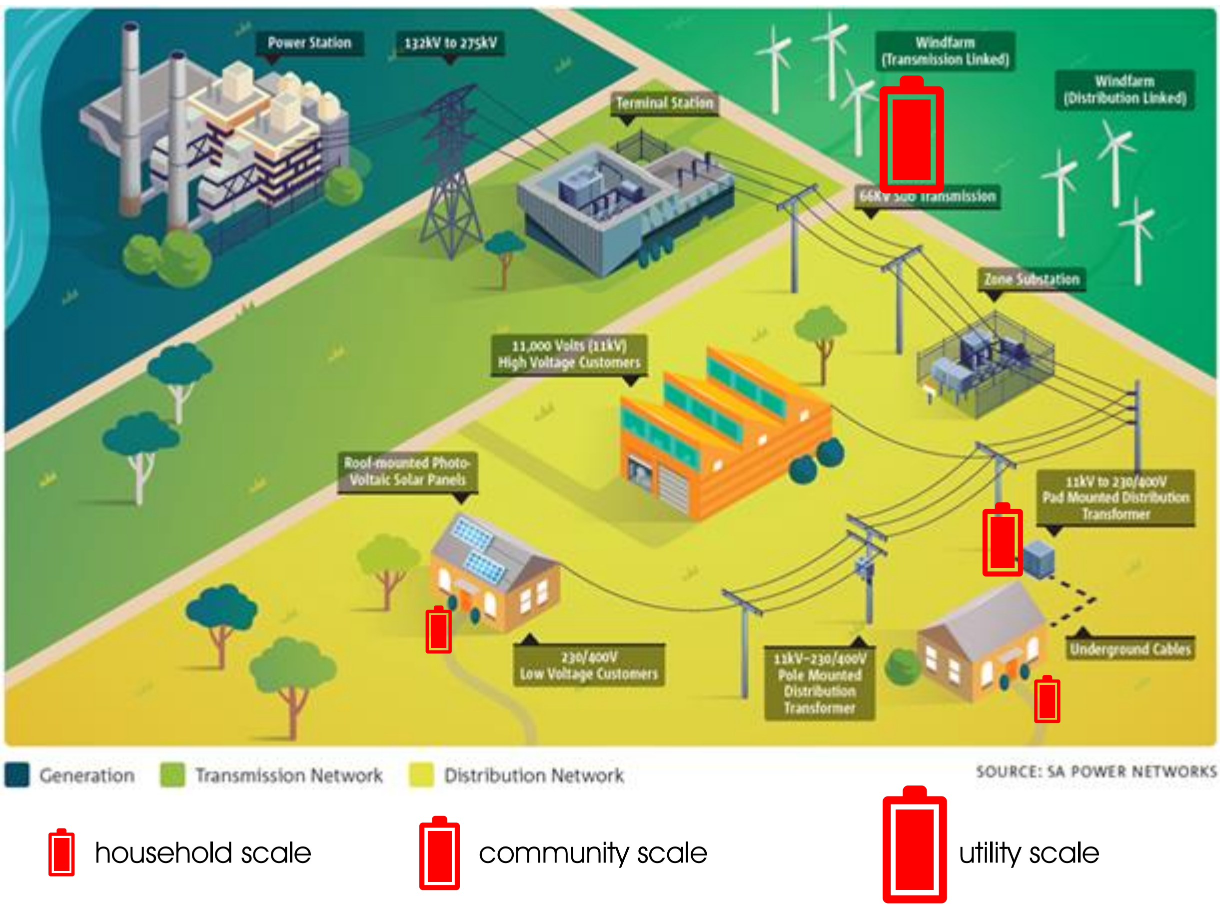

Figure 1: Example electricity supply chain illustrating different scales of battery installations (adapted from infographic produced by SA Power Networks)

For this report and consistent with the work being performed by others this is a scale of several hundred to several thousand kWh of energy storage and the ability to discharge this over around 2 to 5 hours. Australia's most well-known community battery projects have been developed by Western Power. Their 'PowerBank' batteries are Tesla units of around 500kWh with a rated charge/discharge power of just over 100kW[4]. This compares to the popular Tesla "Powerwall 2" units offered as part of South Australia's Home Battery Scheme that are rated at 13.5kWh and 5kW. So, as a guide, community-scale serves dozens of customers rather than an individual customer's 'behind the meter' battery.

South Australia is already home to several larger scale batteries connected to the high-voltage Transmission network and are often referred to as 'utility scale' like the Hornsdale Power Reserve, (aka the Tesla Big Battery) or the Dalrymple battery[5].

2.2 Is a Virtual Power Plant (VPP) a community-scale battery?

An observation from the preparation of this report is that much of the analysis being performed contrasts community-scale (and community owned) batteries with an individual behind the meter battery. The AEMO VPP Demonstration Program only has two active projects and both are in South Australia (Tesla/EnergyLocals and AGL)[6]. These combine hundreds of household batteries.

It was not clear from the analyses reviewed that a community scale, shared battery offers significant benefits over a VPP of multiple behind the meter batteries. It is also possible that smaller shared batteries in apartment buildings or retirement villages or shopping centres could be aggregated into a VPP as well as individual household batteries. Supporting this, AECOM's "Grid vs Garage" report notes that:

> *"There is merit in encouraging an appropriate balance of both utility-scale and smaller battery systems installed in the NEM to reflect the role which different scale BESS can play in the power system."*

For these reasons, this report considers that VPPs can (or could) meet a definition of community-scale batteries and are not necessarily different approaches.

2.3 The consumers of most interest for this research

The aim of this research project was to:

> *Understand under what economic and governance models community scale batteries may assist low income households to reduce electricity expenditure in rental or social housing settings, as well as assistance for communities rebuilding post bushfires.*

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4 https://westernpower.com.au/our-energy-evolution/projects-and-trials/powerbank-community-battery-storage/

5 See https://hornsdalepowerreserve.com.au/ for more information on the 100MW/129MWh "Big Battery" or https://www.escri-sa.com.au/ for more information on ElectraNet's Dalrymple ESCRI-SA Battery Project

6 https://aemo.com.au/en/initiatives/major-programs/nem-distributed-energy-resources-der-program/pilots-and-trials/virtual-power-plant-vpp-demonstrations

Communities rebuilding post bushfires or other disasters have diverse characteristics as energy consumers are discussed more in Section 0.

The primary target is those households often excluded from the adoption of solar, batteries and other energy efficiency technologies. These are discussed further below.

2.3.1 The income, energy and housing nexus

The well documented landlord-tenant split incentive is a fundamental barrier to be overcome in any initiative that relies on significant capital expenditure on housing. This is well understood by the South Australian Government for its Home Battery Scheme and was the subject of specific consultation earlier this year[7]:

> *"The South Australian Government is looking to extend access to the scheme subsidy and low interest loans to rental properties, property developers and aged care facilities to spread the benefits of cheaper electricity to more South Australians.*
>
> *… The take-up of distributed energy resources has occurred primarily by those who own their own home, over a broad socio-economic range. Rental properties with distributed energy are, in nearly all circumstances, cases where homes have likely been rented subsequent to the installation of solar and battery systems"*

The tenancy context for low-income renters varies. Some are able to access public housing through the South Australian Housing Trust and some of these have been able to participate in the Tesla/Housing Trust Virtual Power Plant (VPP) where over 1000 tenants were offered discounted energy plans while 'hosting' solar power, a smart meter and a Tesla Powerwall battery[8]. Others rent from the not-for-profit Community Housing sector[9]. The term 'social housing' tends to refer to both of these opportunities and often rent is tied to income in order to preserve housing affordability. The rest rent from private landlords.

An important attribute shared by almost all renters that is relevant to this project is the relatively modest uptake of solar power. This was highlighted by the SA Government's Home Battery Scheme Issues Paper that referenced several initiatives by other State Governments that sought to make solar more accessible for renters[10].

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[7] Department for Energy and Mining *"Issues Paper: Providing greater access to home battery technology in the private rental market"* available from https://yoursay.sa.gov.au/decisions/home-battery-scheme-access/consultation_process and SACOSS at www.sacoss.org.au/sites/default/files/public/310120_DEM%20battery%20scheme_rentals_SACOSS%20submission.pdf

[8] More information is available from https://virtualpowerplant.sa.gov.au/

[9] More information is available from the Community Housing Council of SA at https://chcsa.org.au/community-housing/

[10] Examples include: https://morelandzerocarbon.org.au/news/solar-for-renters/, www.solar.vic.gov.au/solar-rental-properties, www.qld.gov.au/community/cost-of-living-support/concessions/energy-concessions/solar-for-rentals-trial

2.3.2 Energy Concessions

Energy affordability for around 200,000 South Australian households is significantly improved by access to energy concession payments from the state Government[11].

However, there is also an important customer cohort that have been unable to access these payments. As highlighted in the November 2019 SACOSS Report "Working to Make Ends Meet: Low-income Workers and Energy Bill Stress"[12], those most vulnerable to energy costs are those with low (and often variable) incomes at the energy and housing cost nexus. Those unable to access the South Australian energy concession, solar power or stable, affordable housing are some of the most vulnerable to high energy costs.

It is reasonable to assume that the situation for many of these households has worsened during the COVID-19 pandemic.

As stated in the aforementioned SA Government Issues Paper (p6):

> *"The National Electricity Rules (NER) are framed around the primacy of retail choice driving consumer benefit and protection …"*

According to the Australian Government's energy market comparison tool Energy Made Easy, the two lowest cost retail electricity market offers in the SA market at the time of preparing this report are the South Australian government commissioned "SA Concession Energy Discount Offer" (SACEDO) product from Origin Energy and the offer from Energy Locals for those participating in a Virtual Power Plant (VPP). These are priced at 20% and 35% below the "Default Market Offer" respectively. These are both important government supported offers but, as discussed above, gaps remain in eligibility for our consumer of interest.

2.3.3 What is the problem to be solved?

At this point it is important to emphasise that batteries are being considered in this report as they represent one *potential* solution to the problem of energy bills overwhelming the household finances of those who can least afford it. But it is the size of the bills amongst other essentials – the largest usually being housing – in household budgets that is the problem to be solved. Following this line of inquiry, this report also considers related measures in addition to batteries.

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[11] www.sa.gov.au/topics/care-and-support/concessions-and-grants/concessions/energy-bill-concessions

[12] *Working to Make Ends Meet: Low-income Workers and Energy Bill Stress* "Against a backdrop of increasing electricity prices, energy affordability has been an ongoing concern for many Australians. Historically, earning a living wage (particularly in a full-time permanent capacity) may have protected households from energy-related bill stress. However, this report shows this is no longer the case for many households – a fact which could challenge prevailing orthodoxy about who is in poverty." Available from www.sacoss.org.au/working-make-ends-meet-low-income-workers-and-energy-bill-stress

As stated in the SACOSS Submission to the DEM Home Battery Scheme Issues Paper:

> *SACOSS urges the DEM to keep in mind the fundamental need to reduce energy costs for rental households and that perhaps there are more transparent and optimal solutions to meet this particular goal (for example, focusing on enacting minimum energy efficiency standards for all housing, particularly rentals).*

One of the most striking opportunities at present is the ability to access "other people's solar" at relatively low cost. This is discussed in more detail at Section 4 following a discussion of the economics of batteries.

3 Battery Economics and the Value Stack Challenge

Consistent with The Energy Project's own experiences, presentations at recent webinars from the likes of the Australian National University's Battery Storage and Grid Integration Program, Ausgrid, Western Power and others are clear that at current battery costs, simply storing energy when it is cheap (such as overnight or from the owner's own solar) and re-using it later to avoid retail electricity costs form the grid is not cost effective. AECOM's "Grid vs Garage" report for ARENA is also clear on this point[13]:

> *"To assess the value of the grid and garage options, AECOM looked at the range of services that batteries can offer and their economic value, both for the electricity system and the battery owner. This included:*
>
> - *Load shifting,*
> - *Consumer bill management*
> - *Frequency stability services*
> - *Voltage support services*
> - *Reliability and backup power.*
>
> *Some of the benefits are more obvious than others. Of course batteries can store wind and solar power to cover lulls in generation, but they can also inject power into the grid with lightning speed to keep the lights on if there is a major outage."*

However, batteries can provide other 'services' such as avoided network augmentation, improved network voltage control and accelerated 'decarbonisation' of the local grid through increased solar 'hosting capacity'. Batteries are also proving to be particularly well suited to the NEM's Frequency Control Ancillary Services (FCAS) markets. The ability of batteries to detect deviations in the power system frequency from the standard 50Hz and rapidly absorb or inject power to correct these deviations is being welcomed by the market operator AEMO (Australian Energy Market Operator).

The challenge though is getting paid for these services. That is the 'value stack challenge'.

3.1 Battery life and Capital costs

In our experience, there is not yet significant economies of scale in fully installed battery energy storage systems and an appropriate benchmark 'installed price' of around $1,000 per kWh of useful capacity has existed for several years for anything other than the largest 'utility

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[13] See https://arena.gov.au/blog/is-big-better-when-it-comes-to-batteries/ and https://arena.gov.au/knowledge-bank/grid-vs-garage/

scale' batteries[14]. The South Australian Government's Home Battery Scheme offers rebates of $300-$400 per kWh therefore has a significant impact on the cost of ownership.

Battery economics is driven by up-front costs and what is known as 'cycle life'. The popular Tesla Powerwall 2 is a good case study. This product has a starting useable capacity of 13.2kWh and an energy retention warranty of 70% (i.e. 9.2 kWh) after 10 years[15]. This translates to a stated 'Operating limitation' of '37MWh of aggregate throughput'[16]. With an installed cost of around $10,000[17] this 37MWh (37,000 kWh) equates to an equivalent cost of over $0.25 for each kWh that is cycled through the battery (or more if the money to buy the battery was borrowed and interest is included).

The implication being that the difference in cost between the energy used to charge the battery and that avoided by discharging must be at least $0.25 per kWh to be an economic proposition.

With retail electricity for households priced around $0.35 with discounts (such as Origin's South Australian Concession Energy Discount Offer)[18] and off-peak rates around $0.16 and solar exports priced at $10.10 it becomes clear why the Home Battery Scheme rebate is needed to encourage battery uptake.

3.2 Implications for Community Batteries

FCAS revenue is a critical component of the business case for many battery systems. The March 2020 AEMO Knowledge sharing report on the Tesla VPP highlights the potential for orchestrated batteries to derive FCAS revenue[19] and this is considered in the recent work by the ANU. The ANU Battery Storage and Grid Integration Program has found that community batteries can be feasible under the right circumstances but highlights the role of FCAS revenue (the yellow blocks below) in doing so:

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14 AECOM "Grid vs Garage" Appendix A at https://arena.gov.au/knowledge-bank/grid-vs-garage/
15 www.tesla.com/sites/default/files/pdfs/powerwall/Powerwall_2_AC_Warranty_AUS-NZ_1-0.pdf accessed 12 October 2017
16 approximately 365 days x 10 years x 85% (i.e. the average of 100% in year 1 and 70% in year 10) x 90% efficiency
17 See the Home Battery Scheme System Price Guide at https://homebatteryscheme.sa.gov.au/system/files/documents/System-Price-Guide.pdf
18 www.sa.gov.au/topics/care-and-support/concessions-and-grants/concessions/energy-bill-concessions/energy-discount-offer
19 https://aemo.com.au/en/initiatives/major-programs/nem-distributed-energy-resources-der-program/pilots-and-trials/virtual-power-plant-vpp-demonstrations

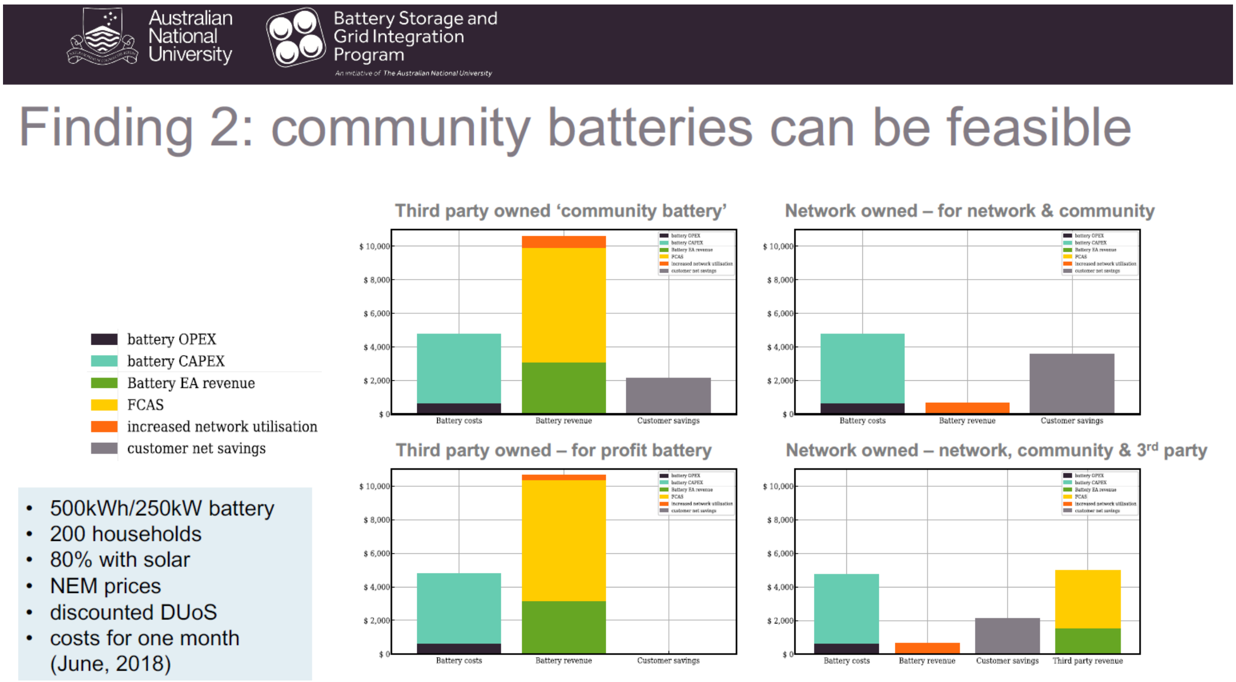

Figure 2 – Early Findings from ARENA funded analysis by the ANU Battery Storage and Grid Integration Program showing that income can exceed costs under some ownership models

A recent Energy Consumers' Australia funded study by consultants Oakley Greenwood (OGW) for The Total Environment Centre "Financial Viability of Community Scale Battery Ownership Models, Feb 2020" also highlights the cycle life limitations of batteries and the role of FCAS revenue in any business case[20].

Accessing the NEM's FCAS markets is not easy – it is only available to 'Market Participants' such as an aggregator like EnelX or an energy retailer like Energy Locals or AGL and in 'units' of 1,000 kW of capacity - and future revenue is not guaranteed. Batteries are currently only able to access the 'contingency' FCAS markets and hence revenue relies on other things going wrong (such as the islanding of South Australia from the NEM in early 2020). However, as was demonstrated by the Tesla VPP and Hornsdale Power Reserve (aka Tesla Big Battery) there is money to be made and the cost to consumers seems to be less than would have been the case without these batteries in the system[21].

What is clear though is that while this is not a revenue source available to an individual 'behind the meter' home battery, both VPPs and 'community scale' grid batteries could participate and the more revenue that can be generated here, the lower the effective cost to any individual consumer that might also use that battery.

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20 https://energyconsumersaustralia.worldsecuresystems.com/grant-archive/1018-community-batteries-a-new-piece-of-the-energy-equity-puzzle

21 See, for example, https://reneweconomy.com.au/tesla-big-battery-at-hornsdale-gets-big-jump-in-revenues-more-to-come-65622/ and http://www.wattclarity.com.au/articles/2020/02/dont-forget-about-fcas/

4 The South Australian Context

Recent publications by the South Australian Government[22], the Australian Energy Regulator (AER)[23] and the Australian Energy Market Operator (AEMO) highlight that significant effort will be needed to ensure South Australians can continue to adopt rooftop solar power. The SA Power Networks distribution network is reaching its 'hosting capacity' and solar power systems are 'tripping' due to elevated network voltages. The AER recently approved expenditure as a result:

> *"Rooftop solar is now mainstream for South Australian households and businesses but that has an effect on the operation of the network. We've funded increased capability to help the network cope with this change.*
>
> *"We've also approved discounted daytime tariffs to encourage consumers to use power when the sun is shining. The decision will allow SA Power Networks to come back to us for more funding if they need to further strengthen the network to cope with very low levels of grid demand during the day"*

The 'uncontrolled' nature of hundreds of thousands of solar systems is also presenting "system security" risks for AEMO on days with a lot of sunshine but little background load – such as weekends and public holidays in Spring[24]:

> *"SA … is at the forefront of the nation's energy transition. Solar PV in SA currently has the capability to provide close to 1 GW of energy under the right conditions (Figure 1), making "consumer" power by far SA's single biggest generator. To put that into perspective, this already world-leading level of solar PV uptake increased by a record 219 MW last year – equivalent to the size of one unit of the state's largest gas-fired power plant.*
>
> *As levels of solar PV grow across the National Electricity Market (NEM), the demand supplied from large, centralised generators (operational demand) continues to decline, especially during the middle of the day. While this is particularly advanced in SA, where minimum operational demand reached a record low of 458 MW last year*

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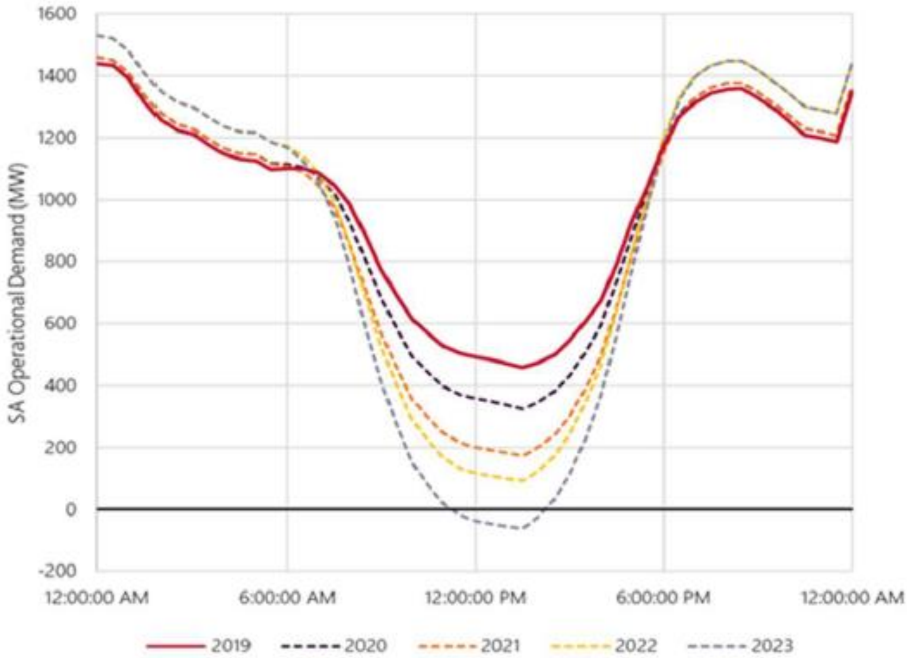
22 See "South Australia's Energy Solution" June 2020 at http://www.energymining.sa.gov.au/energy_and_technical_regulation/energy_resources_and_supply/south_australias_energy_solution

23 https://www.aer.gov.au/news-release/sapn-listens-to-consumer-concerns-in-aer-decision

24 See the 'Ad hoc publications" section of the SA Advisory Functions page at https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/south-australian-advisory-functions for the "Minimum Operational Demand Thresholds in South Australia Review" report and the "Managing South Australia's energy transition" fact sheet.

(see Figure 2, below), all Australian states will need to manage this scenario in coming years."

Figure 2 Effect on SA net operational demand from increasing solar PV generation



The 2019-20 (to date) minimum operational demand of 458 MW occurred at 1:30 pm AEST on 10 November 2019. Figure 2 shows this operational demand projected forward with an annual solar PV growth rate of 219 MW (seen in 2019). On this basis, SA operational demand in the middle of the day is projected to continue to decrease as solar PV levels increase, potentially reaching zero in the next two to three years.

Managing "minimum demand" in spring and autumn is therefore now as important as managing "maximum demand" in summer.

4.1 Impacts of solar and batteries

Solar is now relatively cheap and rooftop installations continue at pace. This is now so pronounced, solar is impacting on the wholesale price of electricity during the day.

Figure 3 overleaf illustrates the average demand (solid blue line) and wholesale market "spot price" (dashed orange line) in South Australia over two years from 1 June 2018 to 31 May 2020. The horizontal axis is divided into the 48 half hour intervals that make up a 24 hour day.

As can be seen, demand and price are low in the early hours of the morning and, importantly, in the middle of the day.

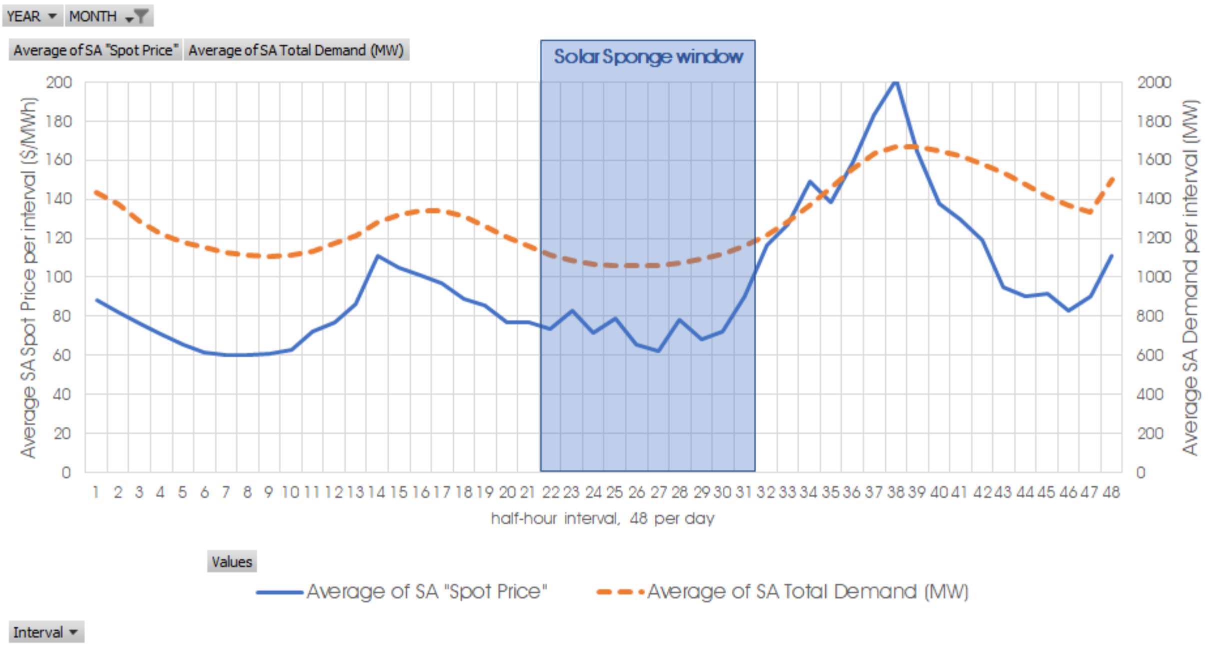


Figure 3 – Average Wholesale Prices and Demand in South Australia June 2018-May2020

Overlaid on this is a shaded area labelled the 'solar sponge window' where demand is at its lowest and prices are low and falling. This is discussed further in the following section.

4.2 Network tariffs

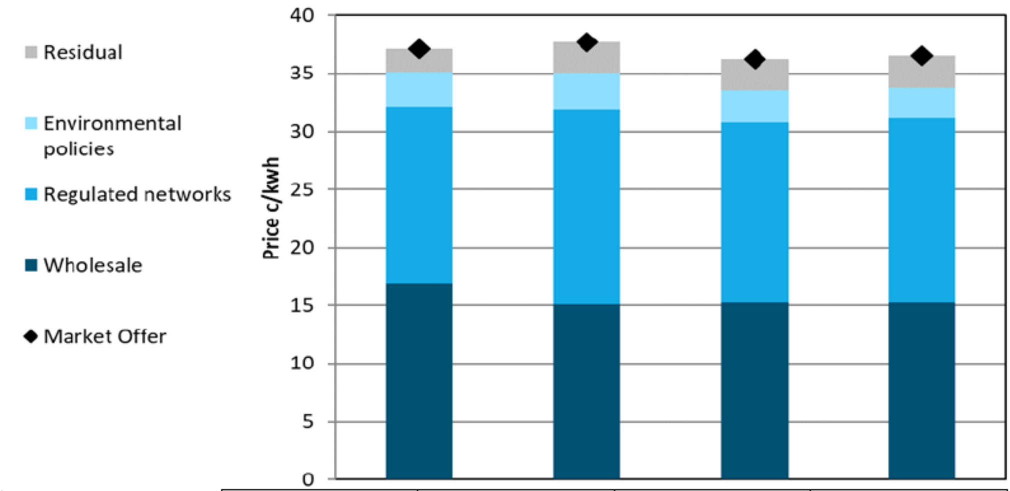
From July 2020, SA Power Networks will introduce new 'time-of-use' (TOU) network tariffs for residential customers with smart meters and will include "solar sponge" pricing. The AER's final determination for SA Power Networks 2020-25 Regulatory Period makes repeated reference to these tariffs. These new tariffs are intended to be 'cost reflective' as required under the National Electricity Rules. The AER stated[25]:

> *"… it is important to note that it is the troughs (minimum demand) not the peaks which are a key cost driver for SA Power Networks at the low voltage (LV) level to which households are connected. This reflects the prevalence of rooftop solar PV amongst households in South Australia. With minimal augmentation expenditure requirements, SA Power Networks' tariff strategy is about moving demand into troughs rather than away from peaks. This is reflected in the substantial discount provided to use of the network between 10:00 and 15:00 when the majority of solar generation occurs."*

[25] FINAL DECISION SA Power Networks Distribution Determination 2020 to 2025 Attachment 18 Tariff structure statement June 2020 page 18-13 available from www.aer.gov.au/networks-pipelines/determinations-access-arrangements/sa-power-networks-determination-2020-25/final-decision

Network tariffs are charged to retailers (such as AGL, Origin, Simply Energy etc) by SA Power Networks and make up around 40% of the typical household electricity bill but is "bundled" by retailers along with wholesale energy costs and other fees and charges. The Australian Energy Markets Commission (AEMC) publishes an annual Residential Electricity Price Trends report. The 2019 report provides the following illustration of the relative size of the various supply chain costs that make up a typical residential electricity bill[26].

Figure 2.9: Trends in SA supply chain components



	2018/19 Base Year		2019/20 Current Year		2020/21		2021/22	
	c/kwh	$/year	c/kwh	$/year	c/kwh	$/year	c/kwh	$/year
Environmental policies	**2.95**	**$147**	**3.16**	**$158**	**2.83**	**$141**	**2.63**	**$132**
LRET - LGC cost	0.77	$38	0.70	$35	0.44	$22	0.30	$15
SRES - STC cost	0.64	$32	0.75	$38	0.68	$34	0.63	$32
Feed-in Tariff Schemes	1.29	$64	1.45	$73	1.45	$73	1.45	$73
REES	0.25	$13	0.25	$13	0.25	$13	0.25	$13
Regulated networks	**15.27**	**$763**	**16.82**	**$841**	**15.51**	**$776**	**15.93**	**$797**
Transmission	3.02	$151	3.25	$163	3.38	$169	3.52	$176
Distribution	11.62	$581	12.89	$645	11.45	$573	11.73	$587
ACS Metering	0.62	$31	0.68	$34	0.68	$34	0.68	$34
Wholesale	**16.90**	**$845**	**15.09**	**$754**	**15.23**	**$761**	**15.22**	**$761**
Residual	**1.96**	**$98**	**2.61**	**$130**	**2.67**	**$134**	**2.74**	**$137**
Market Offer	**37.07**	**$1,854**	**37.68**	**$1,884**	**36.24**	**$1,812**	**36.53**	**$1,826**

Source: AEMC analysis

Figure 4 – Trends in South Australian residential electricity supply chain components

For end users though, these supply chain components appear as the typical retail pricing structure of a fixed 'supply' charge and a volumetric price (in cents per kWh, the basic unit of electricity). For customers with solar or batteries, these costs can be avoided by reduced volume drawn from the grid or offset with payments for electricity 'exported to the grid'. SA Power Networks' tariff structures for 2020-25 are described below (Figure 6) but are more easily understood in the following illustration of the ToU prices across the day (Figure 5):

[26] https://www.aemc.gov.au/market-reviews-advice/residential-electricity-price-trends-2019

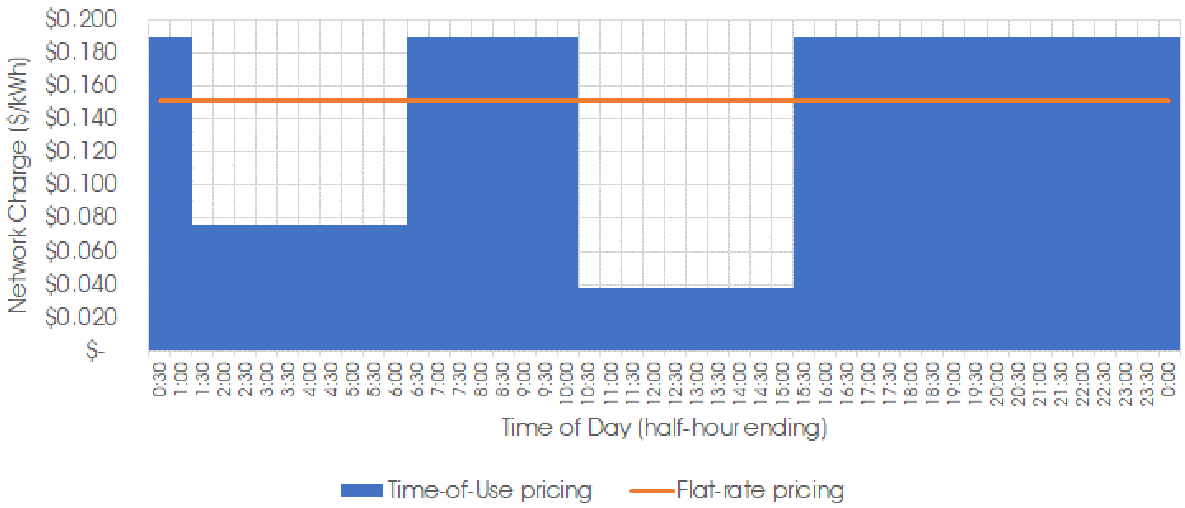


Figure 5 – Illustration of SA Power Networks Time-of-Use vs Flat-rate Pricing for 2020-21

17.4.1 Residential Tariffs

Table 17A-2: Residential tariff structures and charging parameters

Network tariff	Status/ metering	Components	Measurement	Charging parameter
Residential Single rate	**Closed** Accumulation meter (Type 6)	Fixed	$/customer/day	Fixed supply charge per annum
		Usage	$/kWh	Single block usage charge
		Controlled load	$/kWh	Usage-based companion tariff (see below)
Residential Time of Use (ToU)	**Default** Interval meter, either: remotely read (Type 4); or - manually read (Type 5)	Fixed	$/customer/day	Fixed supply charge per annum
		Usage – Peak	$/kWh	Peak Pricing for the 14 hours per day not captured in the off-peak/solar sponge windows at 125% of the single rate price
		Usage – Off-peak	$/kWh	Five-hour off-peak block every day: 1:00am to 6:00am (local time) at 50% of the single rate price
		Usage – Solar Sponge	$/kWh	Five-hour off-peak block every day: 10:00am to 3:00pm (local time) at 25% of the single rate price
		Controlled load	$/kWh	Usage-based companion tariff (see below)
Residential Prosumer *(Supply Charge 25%, Usage Charges 37.5 % and peak demand 37.5%)*	**Opt-in** Remotely read interval meter (Type 4)	Fixed	$/customer/day	Fixed supply charge per annum
		Usage – Peak	$/kWh	Peak Pricing for the 14 hours per day not captured in the off-peak/solar sponge windows at 125% of the single rate price
		Usage – Off-peak	$/kWh	Five-hour off-peak block every day: 1:00am to 6:00am (local time) at 50% of the single rate price
		Usage – Solar Sponge	$/kWh	Five-hour off-peak block every day: 10:00am to 3:00pm (local time) at 25% of the single rate price
		Demand – Summer	$/kW/month Nov-March only	Monthly demand charge based on maximum kW demand measured: • Highest daily average demand over a four-hour period November to March. • Between 17:00-21:00hrs local time
		Controlled load	$/kWh	Usage-based companion tariff (see below)

Figure 6 – Description of SA Power Networks Residential electricity tariffs for 2020-2025

4.3 Implications for Community Batteries

Part of the 'value stack challenge' being targeted by community battery initiatives such as those in Western Australia is the storage for later use of household solar exported to the grid. This is an important aspect of responding to some of the challenges of managing a grid with high levels of solar power such as those in WA and SA. However, the South Australian Government's latest energy plan, "South Australia's Energy Solution – A secure transition to affordable renewable energy" released 19 June 2020 also describes related initiatives that aim to soak up this excess solar (p15):

> *"New retail obligations mean that households will be able to take advantage of cheaper "solar sponge" prices in the daytime and have access to discounted upgrades to improve their efficiency and smart capabilities."*

To the extent that these other measures might better target our consumers of interest – and at lower cost – it is important to consider these as a complement or even substitute for community batteries for these consumers. However, price signals alone are not likely to be enough to ensure benefits to the consumers of interest in the report. The Governments recent Issues paper "Providing greater access to home battery technology in the private rental market" illustrates the sort of approach between government and the energy market that could work (p8, emphasis added):

> *"To ensure consumer protection, there would need to be a high degree of confidence that the residents will derive greater benefit than the costs of annual payments. The Tesla VPP has demonstrated that such programs can be formulated.*
>
> *This would likely require a **role of Government** to prequalify acceptable offers and ensure that battery and solar systems are appropriately sized relative to the dwelling. This may also require **education and access to technology** such as apps which allow households to derive the greatest benefit from self-consumption and virtual power plants. It would also work within the current framework where consumers seek out the best deal from retailers, particularly those with VPP offers."*

Proposed changes to the state's Retailer Energy Efficiency Scheme (REES) to create a Retailer Energy Productivity Scheme (REPS) from 1 January 2021 that will complement these new tariff structures are critical steps to achieving this potential[27]. Energy Consumers Australia (ECA) has also published substantial research and tools for supporting the diversity of energy consumers

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[27] See http://energymining.sa.gov.au/energy_and_technical_regulation/energy_resources_and_supply/consultation_on_regulatory_changes_for_smarter_homes

to engage effectively with energy markets, products and services to seek out lower costs and better value. *Power Shift* is a body of research providing energy companies, government and regulators with evidence on which to build better-targeted and more effective, and innovative energy management services and programs that deliver outcomes for consumers[28].

[28] https://energyconsumersaustralia.com.au/projects/power-shift

5 Regulatory Barriers and Governance Options

5.1 Regulatory Barriers

Recent investigations by the ANU, Total Environment Centre, Energy Security Board, ITP Renewables and others have highlighted a number of regulatory barriers to the uptake of 'shared batteries' beyond those of ownership. High on the list is the application of network charges. Under current market settlement arrangements, electricity bills cannot distinguish between a household's own solar electricity being 're-drawn' from a grid connected battery and the wholesale electricity market, Users would therefore be required to pay 'full price' for electricity when re-drawing their own excess solar back from a shared battery. As shown in Figure 4, this can easily add $0.15 to the cost of stored electricity. While not an insurmountable challenge – alternative approaches to charges are being discussed[29] - households with solar are arguably much less vulnerable to electricity costs anyway.

However, there are at least two network options that could readily overcome these network charging limitations and allow our consumers of interest to benefit from a 'shared battery'. These are discussed below.

5.2 Embedded Networks and Microgrids

5.2.1 What is an Embedded Network?

An Embedded Network (EN) is a private 'utility' network that distributes metered electricity, gas or hot water for sale to end-users. In South Australia, these are also referred to as 'inset networks'.

In a physical sense an EN is simply a parent-child configuration of revenue-grade meters. Common EN examples are apartment blocks, retirement villages, caravan parks and shopping centres.

The two principal activities associated with EN's are:

1. The supply of energy via the physical networks and metering arrangements at each site (network) and
2. The act of selling electricity and gas to end customers (on-selling or re-selling).

[29] For example https://arena.gov.au/knowledge-bank/operating-a-community-scale-battery-electricity-tariffs-to-maximise-customer-and-network-benefits/

Businesses that own, operate or manage an EN and/ or on-sell energy must have either a distribution and/ or retailer licence or an exemption from such licences.

The sale of energy (electricity and/or gas) is a heavily regulated activity with specific consumer protections. The sale of water and hot water is generally not as heavily regulated and operates under the general consumer protections of the Australian Consumer Law (ACL).

Centralised Hot Water is common in higher density developments – either gas or electric powered – and a number of utilities offer to provide the infrastructure (and pay for the gas or electricity used) and then 'on-sell' to residents at a fixed rate ($/kL of hot water used) under a long term (typically 10 year) contract.

Energy regulation is complicated by jurisdictional nuances but, in general, the frameworks aim to ensure that customers within an EN get the same level of price/service options as if they were directly connected to the local network. For South Australia, the regulatory framework for energy ENs is governed by the Australian Energy Regulator (AER) as part of the National Energy Customer Framework (NECF).

ENs are also included in the scope of the "Metering Contestability" changes introduced in December 2017. Under these provisions, all electrical EN customers from this date must be provided with a compliant meter (NEM Type 4) that would allow them to obtain electricity through a retailer of their choice.

In general, gas embedded networks are discouraged under the regulatory frameworks.

5.2.2 Embedded Electricity Networks, Batteries and Solar

Electrical ENs can allow for more cost-effective utilization of solar power on site than would otherwise be the case. By consolidating consumption 'behind the meter' larger, more cost-effective solar power systems can be incorporated than if only provided to meet common area loads. Recent Australian research from the University of NSW shows how shared solar and batteries are more effectively utilised in apartment buildings with embedded networks[30]. The same would apply to other ENs such as medium density Community Housing developments, retirement villages and caravan parks.

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30 Roberts, Bruce & MacGill "Impact of shared battery energy storage systems on photovoltaic self-consumption and electricity bills in apartment buildings" in Journal of Applied Energy 245 (2019) https://doi.org/10.1016/j.apenergy.2019.04.001

5.2.3 Governance considerations

The central consideration for establishing an EN is that of the ownership model post-development and the different incentives between development and ongoing operations.

It is common for developers to be offered a 'turnkey' solution whereby the electrical or hot water infrastructure (not cables or pipes) is funded by the solution provider in exchange for being the incumbent provider under a contract novated to an Owner's Corporation (OC) or similar entity that becomes the counterparty to this ongoing contract.

While this results in avoided costs to developers for metering and/or hot water infrastructure (and in some case result in cash rebates being offered), the result for residents is not always so positive. This was the basis of consumer research in Victoria and a story by the ABC's 7.30 Report in 2019[31]. Governance options dictate the consumer benefits of these arrangements and while many apartment dwellers and caravan park residents have reported negative experiences with these arrangements – being 'stuck' on high tariffs with no real choice of retailer - this does not have to be the case. Under different management, the exact same physical configuration of an embedded network can become the 'solar/battery microgrid' imagined by some as a vision of the future electricity market.

The Energy Project provides regulatory compliance support to a range of clients that own shopping centres, apartment style accommodation and shopping centres. We have experience with Retirement Village ENs that are operated on a simple cost-recovery model that deliver electricity prices well below the best prices in the market for residential consumers. A shared battery combined with solar on individual dwellings and/or common areas that could also capture more of the value stack is likely to be cost effective if implemented at an appropriate scale. In our experience this is likely to require multiple sites to aggregate to 1MW of capacity in order to participate in FCAS markets – a VPP of microgrids.

5.2.4 Shifting regulatory landscape

The Australian Energy Markets Commission (AEMC) – the national energy rule maker - released the final report of its "Updating the Regulatory Frameworks for Embedded Networks" project on 20 June 2019[32].

[31] www.abc.net.au/news/2019-10-30/embedded-electricity-networks-energy-customers-paying-too-much/11653730
[32] www.aemc.gov.au/market-reviews-advice/updating-regulatory-frameworks-embedded-networks

The AEMC has previously found that the current regulatory arrangements for embedded electricity networks are no longer fit for purpose, resulting in some customers not being able to access competitive prices or important consumer protections.

The AEMC has now developed a new regulatory framework for embedded electricity networks. Under the new framework two new roles will be created. EN owners will eventually need to become or procure these roles:

- Embedded Network Service Provider (ENSP), which will be required to register with the Australian Energy Market Operator (AEMO) and will be subject to many of the existing regulatory requirements placed on Distribution Network Service Providers (DNSP's), and
- Off-market retailer (OMR), which will be required to obtain an authorisation from the Australian Energy Regulator (AER), and will be subject to most requirements that existing authorised retailers are subject to.

The AEMC's final report presents a package of law and rule changes. The proposed framework however will not be implemented until COAG Energy Council has redrafted electricity and energy retail laws based on the AEMC's proposed law change descriptions, and these have been made by the South Australian Parliament. As at June 2020, there is still no publicly available timeline for this to occur.

It is worth considering if the delayed implementation of the reforms is a barrier to pursuing embedded networks based community battery opportunities for the consumers of interest for this report. For this reason, the related recommendation is to pursue this in the not-for-profit Community Housing sector rather than private rental at this time.

5.3 Distributor-led Stand-Alone Power Systems

The South Australian Government has offered free home batteries to the 188 households rebuilding after the 2019-20 bushfires[33].

The Australian Energy Markets Commission (AEMC) has recently approved a rule change that will support 'Stand Alone Power Systems' (SAPS) being used by SA Power Networks to deliver electricity to communities that are at the edges of the grid or in high bushfire risk areas[34].

Communities rebuilding after bushfires or other disasters offer different opportunities: batteries can substitute directly for other infrastructure costs. These important reforms may create opportunities for community scale batteries either as part of creating a SAPS or in anticipation

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33 https://dhs.sa.gov.au/services/disaster-recovery/home-battery
34 www.aemc.gov.au/market-reviews-advice/updating-regulatory-frameworks-distributor-led-stand-alone-power-systems

of a transition from grid supply to a SAPS. Interstate examples of this sort of initiative are the 'Consort' battery trial on Tasmania's Bruny Island – where an upgrade to the local network has been deferred through orchestrated batteries[35] – and in Western Australia. The WA initiative explores the potential to eventually take some customers "off grid"[36].

Local examples with potential would include the western end of Kangaroo Island where a very low density of customers are served by long distances of Single Wire Earth Return (SWER) network or the west coast communities of Streaky Bay or Ceduna – important population centres served by long distance of network at the most western parts of the National Electricity grid:

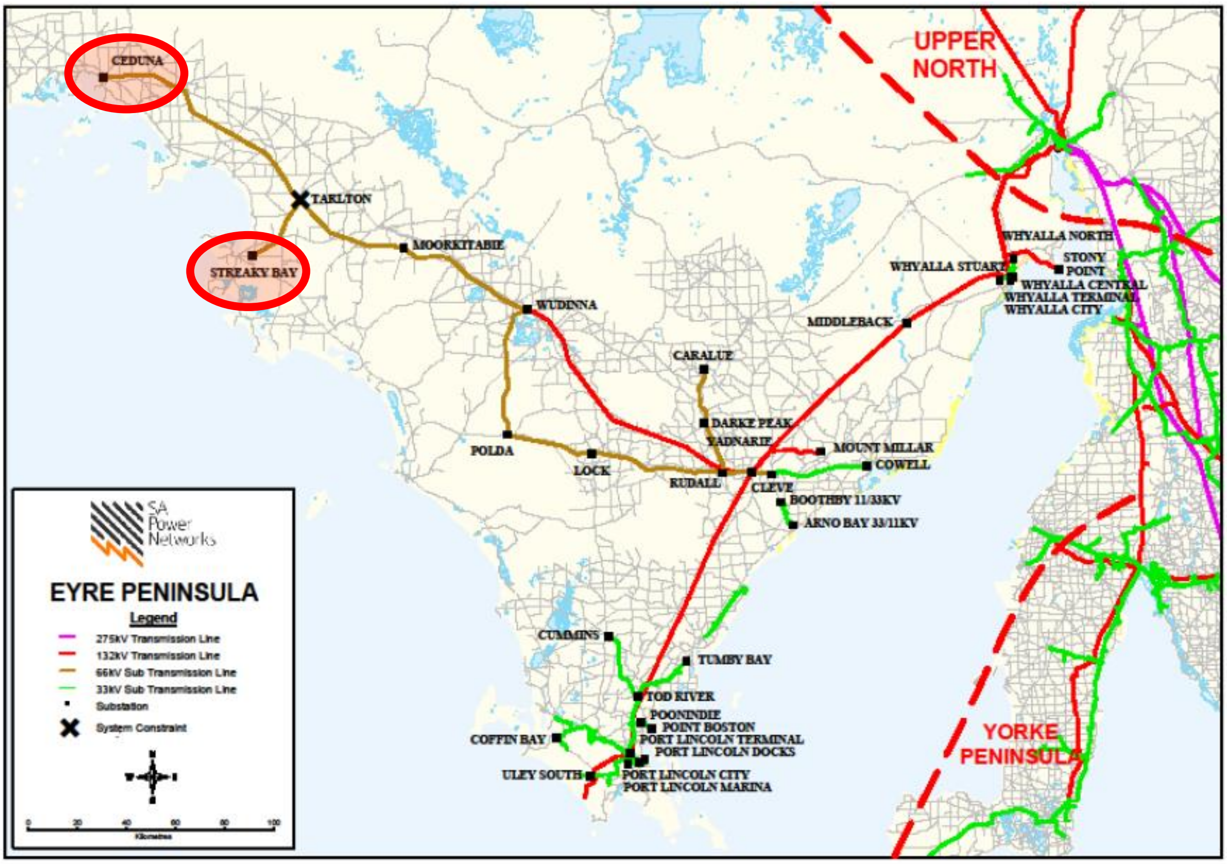

Figure 7: SAPN Eyre Peninsula electricity network map showing the communities of Streaky Bay and Ceduna at the far western end of the grid[37]

35 More information on the Bruny Island trial is available at http://brunybatterytrial.org/

36 More information at https://westernpower.com.au/our-energy-evolution/grid-technology/stand-alone-power-system/

37 From www.sapowernetworks.com.au/industry/annual-network-plans/

6 Summary and recommendations

The aim of this research project was to:

> *Understand under what economic and governance models community scale batteries may assist low income households to reduce electricity expenditure in rental or social housing settings, as well as assistance for communities rebuilding post bushfires.*

What we found was that while batteries at a range of scales are important and valuable components of our future electricity system a myriad of economic and governance challenges exist to make it difficult to accrue enough 'value' in our competitive electricity market to make the capital cost worthwhile. This is known as the 'value stack challenge'. South Australia's success with Virtual Power Plants is also unique in the NEM and potentially represents a 'here and now' alternative to overcoming the economic and governance challenges of shared batteries at a community scale.

However, beyond the challenges and opportunities of community scale battery storage in general, there is the specific objective of lowering the energy costs of renters without solar and communities rebuilding after bushfires or other disasters.

Recommendation 1: Transition to standalone supply

Consideration be given to trialling community scale batteries in the context of communities recovering from bushfires, in high bushfire risk areas and at the very edges of the grid that might one-day be most efficiently and effectively served by going 'off grid'. One or more community scale shared battery could be an effective tool in the transition to such a solution.

Recommendation 2: Embedded Network Pilot project

Consideration be given to demonstrating the potential of a medium to high density community housing development using shared solar and storage in an embedded network to lower the overall cost of energy to residents. There is a notable gap in the research reviewed around contrasting community scale batteries with VPP options and such a trial would complement the lessons being learned from South Australia's Home Battery Scheme and related VPPs.

Recommendation 3: Support SA Government Initiatives to introduce Time-of use pricing

Wholesale market price trends and regulated network tariffs are delivering electricity to retailers during the middle of the day that is significantly cheaper than what a simple flat rate tariff would reflect. As a complement to considering batteries, a case exists to ensure that vulnerable customers can access this cheaper electricity if it delivers overall lower costs. It is therefore recommended that SACOSS support the proposed mandating of a Time-of-use (TOU) retail standing offer for all retailers in South Australia and support the realigning of the REES to REPS – a scheme that recognises the benefits of measures that reflect the time of day that electricity is used.

Recommendation 4: Retail electricity offer and other complementary measures for renters

Mandatory TOU standing offers are a welcome start but competitive market offers must follow. Like the South Australian Concession Energy Discount Offer (SACEDO), there is a case for a government sponsored retail time of use market offer for those who would benefit. This would need complementary measures (such as education and other support) to ensure the potential benefits are realised. It is recommended that SACOSS advocate for a package of measures that would see the SA Government initiatives targeted at the consumers of interest for this report.

7 Overview of Current initiatives

The various reports and initiatives related to Community-scale batteries reviewed for this report are summarised below.

Energy Consumers Australia has supported a number of battery initiatives including a summary of the uptake of batteries in Australia and implications for NEM energy market policy – "Charged Up" by Engineroom Infrastructure Consulting (March 2020)[38]. Of direct relevance to this report was work by Oakley Greenwood Consulting for the Total Environment Centre (February 2020) - "Community batteries: A new piece of the energy equity puzzle?"[39]

ARENA recently engaged consulting firm AECOM to explore the pros and cons of deploying battery storage at different points in the electricity network. The resultant report "Grid vs Garage" found that both grid and garage batteries offer benefits for the electricity market and owners, but that positioning them on the low voltage network was the most effective option. This allows expenditure on distribution upgrades to be deferred, creating the most value for the electricity system[40].

The Energy Security Board (ESB) has engaged ITP Renewables to understand Community Battery Business models and Regulatory Barriers and sponsored a series of webinars to disseminate research and promote debate[41].

The Australian National University (ANU) Battery Storage and Grid Integration Program has a multi-disciplinary research program relevant to community batteries[42]. Social research is due to be published in July 2020.

The Western Australian Government's Distributed Energy Resources Roadmap and related projects from Western Power[43].

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38 https://energyconsumersaustralia.worldsecuresystems.com/grant-archive/1017-predicting-the-emergence-of-battery-systems-at-a-residential-and-wholesale-level-and-the-result
39 https://energyconsumersaustralia.worldsecuresystems.com/grant-archive/1018-community-batteries-a-new-piece-of-the-energy-equity-puzzle
40 https://arena.gov.au/knowledge-bank/grid-vs-garage/
41 https://www.bigmarker.com/esb1/Community-scale-batteries-webinar
42 More information at https://bsgip.com/
43 See https://www.wa.gov.au/government/publications/der-roadmap and https://westernpower.com.au/our-energy-evolution/projects-and-trials/powerbank-community-battery-storage/