THE JACKA COMMUNITY BATTERY:

FEASIBILITY STUDY

The ANU Battery Storage and Grid Integration Program

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1 Executive Summary

Due to their unique size and position in the grid, community-scale batteries have the potential to play an integral role in Australia's transition to a decentralised grid. Our research at the ANU has found that there is enthusiasm for storage of this scale, both from householders and energy sector professionals [1]. Our simulations suggest that community-scale storage is economically feasible [2], and can provide more effective local energy management in distribution networks, compared to the equivalent capacity of household batteries [3]. In Western Australia, where regulations allow state-owned utilities to own and operate community-scale batteries, several trial community battery projects have already proven successful [4], [5].

The ANU Battery Storage and Grid Integration Program (BSGIP) was engaged by the Suburban Land Agency (SLA) to investigate the feasibility of a community battery in the greenfield suburb of Jacka, ACT. This study has been carried out with extensive discussions and consultation with the local DNSP, Evoenergy. Overall, we found that storage of this scale could provide cheaper and more effective local energy management, compared to the equivalent capacity of household storage.

The results in this study are based on a simulation that was carried out to evaluate community battery options for approximately 600 single-dwelling households in this all-electric suburb. We found that multiple community batteries installed on the low voltage (LV) network would provide the best daily demand management.

Key findings:

- A community battery could provide cheaper and more effective local energy management in Jacka, compared to household storage
- Multiple LV community batteries would provide an opportunity to test the use of this technology for demand and voltage management on LV networks
- According to simulations, a battery or a set of batteries of total capacity 928 kWh, could reduce energy imports and exports on the order of 20%
- For a battery of this scale, total project cost around $1M with annual revenue up to $370K
- As Jacka is a greenfield development, it offers the opportunity to trial innovative ownership and operation models, including new models for customer participation

Key challenge: Ensuring that the battery owner and operator will operate the battery to benefit all stakeholders e.g. Jacka householders, the battery owner, *and* the local network operator (Evoenergy).

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1. *makes no warranty as to the accuracy or completeness of the Feasibility Study Report; and*
2. *does not purport to adopt any of the statements or representations in the Feasibility Study Report as its own statements or represen-tations.*

Stakeholders and other interested parties must rely on their own enquiries and independent advice in respect of the Jacka community battery project.

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Glossary

API Application programming interface. 19

DER Distributed energy resources. 6

DMIS Demand management incentive scheme. 18

DNSP Distribution Network Service Provider. 1, 6–8, 11, 16–22

DUOS Distribution Use of Service. 11, 16

FCAS Frequency Control Ancillary Services. 7, 11, 16

LUOS Local Use of Service. 9, 16, 17, 19

LV low voltage. 1

MASS Market ancillary services specification. 19

NEM National Electricity Market. 6, 7, 11, 16–18, 21, 22

NMI National metering identifier. 19

PPA power purchase agreement. 17

RIT-D Regulatory investment test for distribution. 18

SGA Small Generation Aggregator. 6, 17, 18

VPP virtual power plant. 18

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2 Battery storage reduces total net energy imports (yellow) and total net energy exports (orange), from the upstream substation to the whole Jacka network. LV community batteries result in the greatest reduction, with around 30% reduction in both imports and exports. LV = low voltage, MV = medium voltage. 12

3 Community batteries reduce mean daily power imports (yellow) and exports (orange), to/from the whole Jacka network. The reduction was greatest with community batteries on the LV network. LV= low voltage, MV = medium voltage. Note that household batteries resulted in a slight *increase* in daily peak power exports. 13

4 Battery costs and total daily power reduction for three different total battery capacities (multiple batteries on the LV network). A total capacity of 928kWh provides a good trade-off of total battery cost compared to power reduction that can be achieved. Note that for this total battery capacity, total energy import/export into and out of Jacka was reduced by around 20%. 14

5 The mean voltages across nodes in the simulated Jacka network are within the acceptable voltage range (0.94 and 1.1 p.u.), even with 100% solar PV penetration. The community batteries still have a minor impact on voltages. A slight reduction in the highest and lowest voltages with the battery (yellow) compared to without (teal), can be seen, more so when the battery is placed on the LV network (left) than on the 11kV MV network (right), as expected. 15

6 Implementing the Jacka community battery will require metering, telemetry, integration, and control capabilities. In this diagram the participating users in the community battery model are highlighted in red. 19

2 Potential ownership and operating models for the Jacka community battery

A community battery in Jacka could be owned by a range of potential parties, including a government agency, a community group, an electricity retailer or an aggregator, a private investor or the local DNSP (Evoenergy). According to the project specifications:

- The battery/batteries would be physically located on existing DNSP-owned pad mounts, adjacent to the planned distribution transformers in the new suburb.
- The battery/batteries should be operated to benefit all stakeholders (householders, the battery owner and the network operator), as opposed to operating only to profit the battery owner.
- Caution must be taken that the community-scale battery, through participating in wholesale and ancillary services markets, does not push networks beyond their physical and operational limits. We have directly observed the potential for this outcome in our research [6].

Retailer ownership: A retailer, for example, might be keen to offer virtual storage as an extra service for customers. Indeed, retailers are well positioned to access the energy market and to engage customers with on-bill participation models such as tariffs and subscriptions. Caution should be taken with retailer-owned models as our earlier research has shown that members of the public are wary of the profit motives of retailers and often have significant issues with the opaqueness of tariffs and bills [1].

Aggregator ownership: Alongside electricity retailers, there is an emerging category of providers that are specialising in aggregation capabilities. This includes small generator aggregators (SGAs), DER aggregators and market ancillary service providers (s). An aggregator may choose to add the community battery to their demand management fleet.

DNSP ownership: The local DNSP, Evoenergy, could, in theory, own the Jacka battery. However, in practice, this would be difficult due to existing rules and regulations around what services DNSPs can deliver with batteries they own. (NEM) rules and regulations only allow DNSP owned assets to deliver regulated network services, such as supporting voltage in weak parts of the network or deferring a larger network investment.

A Government agency or a community energy group: This category of owner may require extra support to manage the complexities around contracts and the technical aspects of the project (e.g. metering and communications).

Whatever the ownership model for the Jacka community battery, having community involved will likely increase the acceptance of such a community energy project and may facilitate efforts around demand management, as there is a sense of ownership and "care" towards the community asset [1].

2.1 How will households participate?

There are a range of ways households in Jacka could interact with a community-scale battery.

1. Households sign up for a specific community-scale battery energy tariff or subscription: In Western Australia (WA), such offers have been trialled by Western Power - a vertically integrated DNSP and retailer. Caution is required to ensure this arrangements benefits all customers equitably e.g. in WA, subscriptions have only been offered to customers who have solar systems that are exporting a significant amount of energy into the grid. Like most modern electricity tariffs (time-of-use, demand based), it is difficult to predict the likely benefit to customers, without careful analysis of individual load and solar generation profiles. For example, in the Alkimos trial, despite pre-vetting of customers, some customer's electricity bills increased in the community-scale battery scheme compared to prior [7].

2. Households receive a small financial benefit through their retail bill: For example, the retailer could pass on a discounted network tariff to all households, or an increased feed-in tariff.

3. Households could benefit indirectly, not through any billing arrangement: For example, a government agency could own the battery and redistribute profits to the community. Alternatively, a third party could own the battery and return dividends to community members who invested in the battery. These types of models are highly flexible, allowing them to target specific distributions, which may either improve or exacerbate inequality.

2.2 Services the battery can provide

In addition to providing energy storage for households, the Jacka community battery is also in a position to provide both market and non-market services. Participating in market services including both energy market and ancillary services markets (e.g. FCAS) will increase the financial viability of the battery. Non-market services include the use of the battery to provide network services, including demand management, management of thermal and voltage constraints, together with resilience benefits (this was noted in the 2019-20 National Energy Market (NEM)

Summer Operations Review Report [8]). Non-market services could also include the use of battery storage to achieve sustainability goals e.g. emissions reductions. Mechanisms for the local DNSP to pay the battery owner for these services already exist, as discussed in more detail in 5.3.

3 Feasibility study

In this feasibility study, we compared four energy storage scenarios for the greenfield suburb of Jacka in the ACT. Those scenarios were:

1. No energy storage
2. Household batteries (40% penetration, 240 in total), evenly distributed, total capacity 1085kW/2142kWh
3. Multiple community-scale batteries (one on each of the six LV feeders), total capacity 1085kW/2142kWh
4. A single community-scale battery on the MV (11kV) network, total capacity 1085kW/2142kWh

3.1 Study scope

The analysis sought to investigate various impacts including:

- Increased load due to suburb being all-electric, including electric hot water and heating and cooling systems
- Fast charge EV charge points (up to 20-30kW) at community sites
- High level of rooftop PV generation, including potential for PV for multi-unit sites
- Variable number of houses in suburb, accounting for slow purchase and uptake rates the potential need for onload tap changers installation/construction costs
- Access to markets
- Network charges

Modelling assumptions
600 connection points, mostly residential
load/PV – real data from the Nextgen residential Battery Storage Trial
80% PV penetration, total solar PV 2.9 MW (avg. 6.2kW/house)
Battery control strategy: peak reduction and cost minimisation
2018 spot maket prices plus DuOS=$0.07, LUOS=0
Battery simulation and calculations: BSGIP open-source c3x package [4]
Optimiser given perfect foresight
Simulation duration = 6 months (January-June 2018)
Shared storage – customers with and without solar can equally access the battery

Table 1: Modelling assumptions

Parameter	value
battery type	Lithium
battery life	10 years
Degradation	not considered
battery round-trip efficiency	90%
battery C-rate	0.5
η_{ch},$\eta_{discharge}$	95%, 100%
battery throughput cost	3.2c/kWh

Table 2: Battery parameters used for the simulation

3.2 Simulations

Modelling assumptions are given in table 1.

Data: The simulation was based on load and solar data from the Nextgen Residential Battery Storage trial, based in the Australian Capital Territory (ACT) [9]. Here, we used only 140 trial households and randomly sampled from this subsample to generate the data for 600 households in the current analysis. The Nextgen data include both residential and industrial customers, which we assume provides a reasonable dataset for an all-electric suburb with residential customers.

To simulate the charging/discharging pattern of the battery, we used our open-source c3x software [10], developed by the Battery Storage and Grid Integration program. Battery operation was dictated by multi-objective optimisation (cost minimisation combined with peak shaving). Battery parameters used for the simulation are given in table 2.

Power flow analysis: Energy flows were calculated using c3x software [10] together with smart grid toolbox, a Smart Grid Simulation Library [11].

Electricity network: The network was created to be representative of the Jacka network and is not the exact Jacka network map (Fig. 1). We used a similar topology and obtained the network parameters (impedance, capacitance) from Evoenergy.

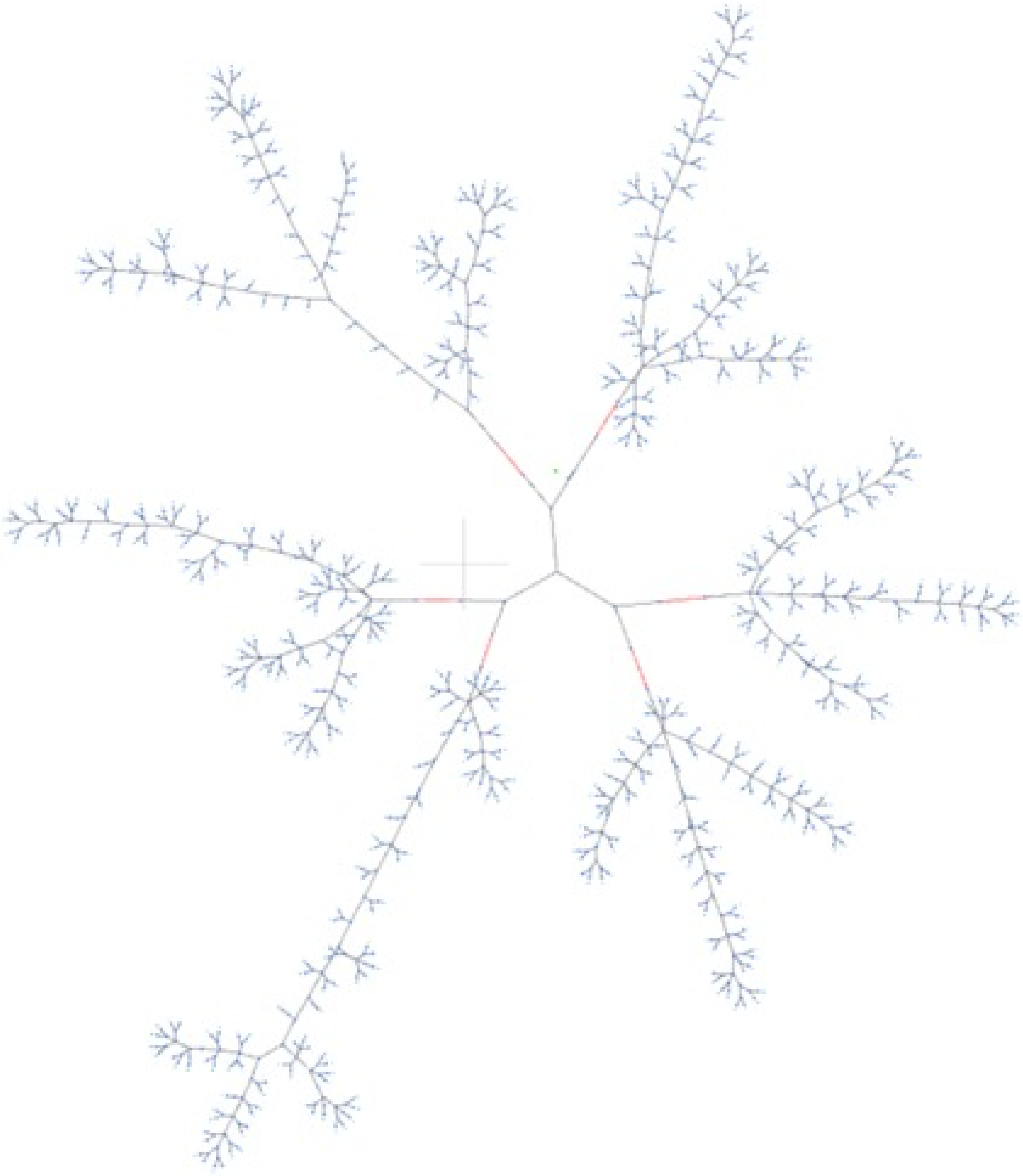


Figure 1: Jacka network map used for the modelling in this study

3.3 Battery costs and revenue

We assumed battery costs of AUD $1000/kWh, based on a report from AECOM [12]. The battery capital expenditure (CAPEX) was defined as battery capex = cost/kWh x battery capacity. Assuming zero interest rate, annualised battery cost was the cost of the battery capex divided by the battery life . The battery operation expenditure (OPEX) was based on a figure of AUD$16/kWh per annum [12].

Note that we did not calculate customer costs/savings. In practice, the customer's choice of retailer would determine how much the customer pays for their energy consumption and is paid for their 'feed in tariff' (FiT). We assumed that energy transport (DUOS) within the Jacka network is free, waived by the DNSP. In our modelling, we have allowed all customers, with or without solar PV, to purchase energy from the community battery.

FCAS calculations: The battery can participate as both a generator and a load in the FCAS market. Here, we assume that the battery will only participate in the six contingency services, as battery operation for regulation FCAS requires significantly greater energy throughput. Those contingency services are: generation across three time periods (RAISE6sec, RAISE60sec, RAISE5min) and load across three time periods (LOWER6sec, LOWER60sec, LOWER5min). Market prices vary across regions in the NEM. Here, we calculated potential FCAS revenue based on prices from the NEM site for NSW region for the corresponding day in 2018. These are provided in 30 minute intervals which were resampled to 5 minute intervals. The minimum generation/load quantity to offer on the market is currently 1MW. We assume that, if the battery is less than 1MW, it is participating in an aggregation scheme where collective assets can contribute above the minimum bid.

Clearly, a large component of estimated battery revenue comes from FCAS markets. It should be noted that, given an increasing amount of storage coming onto the market, and limited FCAS requirements, FCAS prices are expected to fall substantially. A recent report by AECOM, commissioned by ARENA, assumed that FCAS prices in each market would reduce exponentially to 10% of current values by 2040 [13].

4 Results

4.1 The impact of the battery on local energy management

Fig. 2 shows the total net energy imports (yellow) and exports (orange) into and out of the suburb of Jacka, for the four storage scenarios tested: no storage, household batteries, LV community batteries and a single MV community battery. Results show that the six LV community batteries provide the best reduction in energy imports and exports (30% reduction). Likewise, the six LV community batteries resulted in the highest daily peak power reductions (Fig. 3).

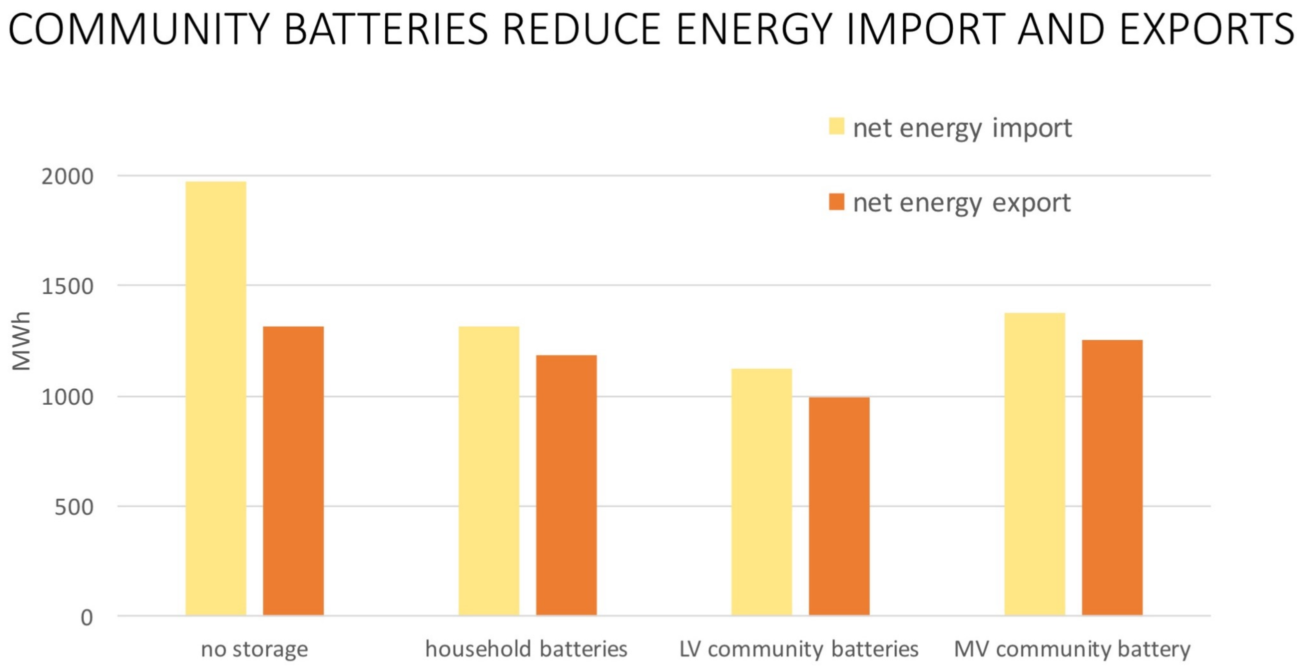


Figure 2: Battery storage reduces total net energy imports (yellow) and total net energy exports (orange), from the upstream substation to the whole Jacka network. LV community batteries result in the greatest reduction, with around 30% reduction in both imports and exports. LV = low voltage, MV = medium voltage.

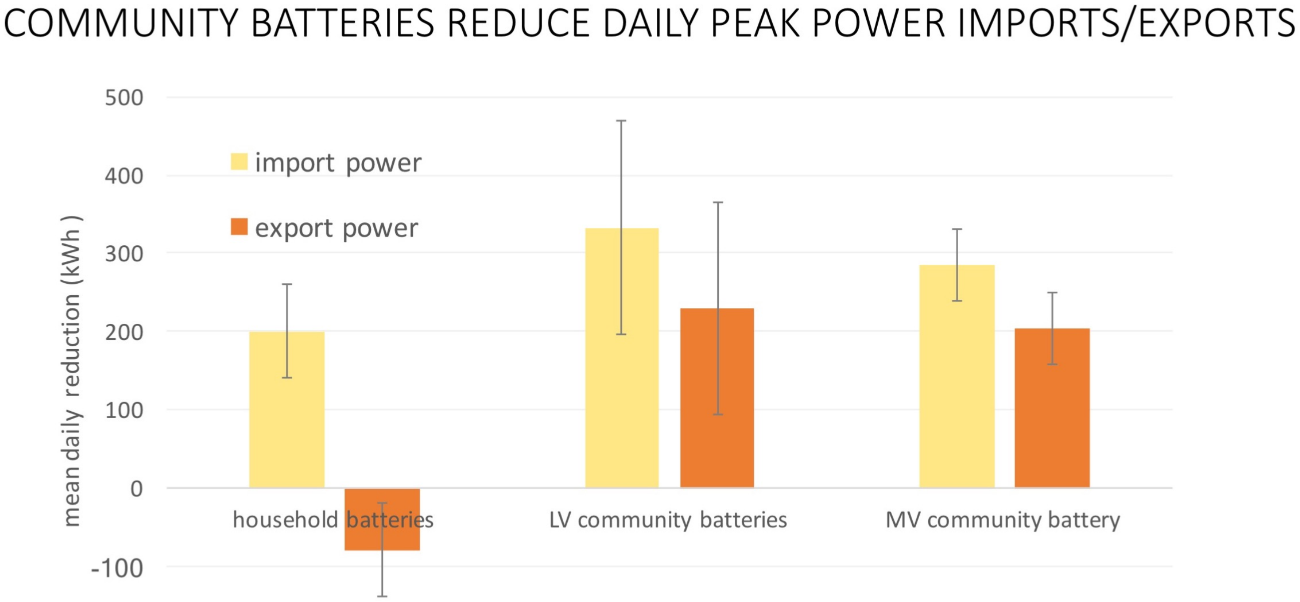


Figure 3: Community batteries reduce mean daily power imports (yellow) and exports (orange), to/from the whole Jacka network. The reduction was greatest with community batteries on the LV network. LV= low voltage, MV = medium voltage. Note that household batteries resulted in a slight *increase* in daily peak power exports.

4.2 What size battery for Jacka?

Fig.4 shows the battery cost and total daily power reduction for three different total battery capacities (462, 928, 2142kWh). This simulation was based on six batteries on the LV network. A total capacity of 928kWh appears to provide a good power reduction per cost ratio. For this size battery, total energy imports/exports into and out of Jacka were 17 and 18% respectively. All subsequent cost/revenue calculations were made on the basis of this total battery capacity (928kWh).

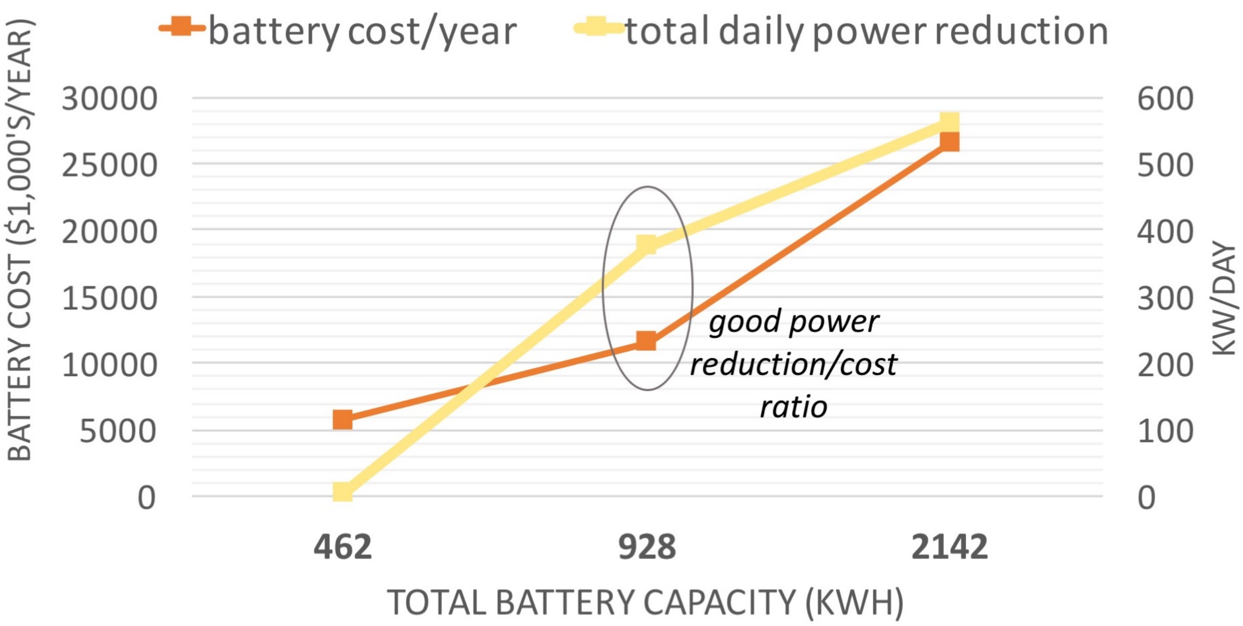
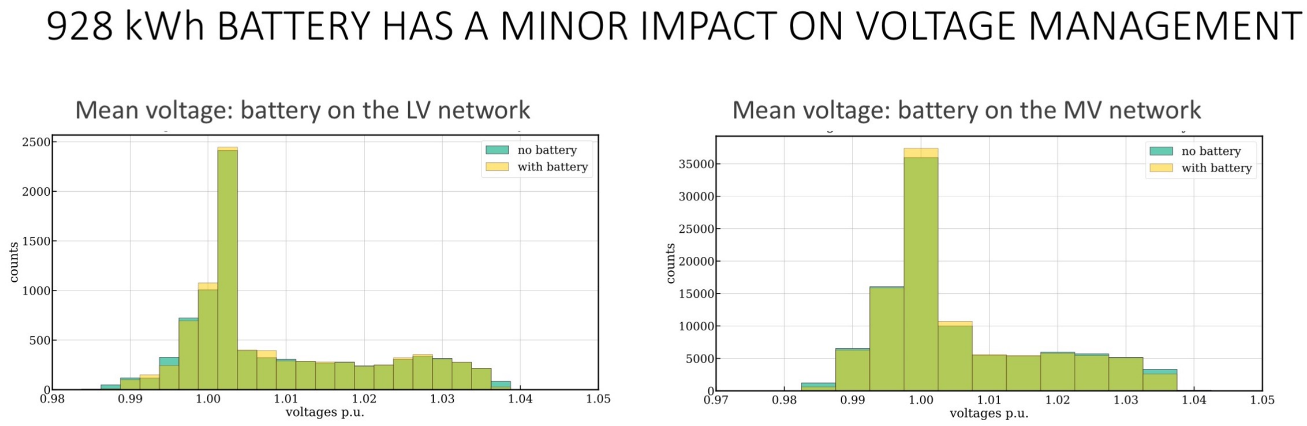


Figure 4: Battery costs and total daily power reduction for three different total battery capacities (multiple batteries on the LV network). A total capacity of 928kWh provides a good trade-off of total battery cost compared to power reduction that can be achieved. Note that for this total battery capacity, total energy import/export into and out of Jacka was reduced by around 20%.

4.3 Community battery placement: the LV or the MV network?

As shown in Fig. 3, daily peak power reductions were greatest with the community batteries sitting on the LV side of the distribution transfomers. Fig. 5 looks at the impact of the battery placement on voltage management in the Jacka network. Overall, the mean voltages across nodes in the simulated Jacka network were within the acceptable voltage range (0.94 and 1.1 p.u.), even with 100% solar PV penetration. However, the batteries were still shown to have a minor impact on reducing/increasing the highest/lowest voltages, for a battery size of 928kWh, more so when the battery was placed on the LV part of the network, compared to the MV part, although the effects were minor. It is important to note that, although voltage management may not be a current issue in the Jacka network, it is a common issue in LV networks and the Jacka project could play an important role as a test-bed for the use of a community battery for voltage management in LV networks.


928 kWh BATTERY HAS A MINOR IMPACT ON VOLTAGE MANAGEMENT

Mean voltage: battery on the LV network

Mean voltage: battery on the MV network

Figure 5: The mean voltages across nodes in the simulated Jacka network are within the acceptable voltage range (0.94 and 1.1 p.u.), even with 100% solar PV penetration. The community batteries still have a minor impact on voltages. A slight reduction in the highest and lowest voltages with the battery (yellow) compared to without (teal), can be seen, more so when the battery is placed on the LV network (left) than on the 11kV MV network (right), as expected.

Battery costs ($/year)	
Battery CAPEX (928kWh * $1000/kWh/10 years	$92,800
Battery OPEX (928kWh * $16/kWh)	$14,848
TOTAL	$107,648
Battery revenue ($/year)	
Energy Arbitrage	$255,885
FCAS	$118,065
TOTAL	$373,950

Table 3: Battery costs and projected revenue

4.4 Project costs and estimated revenue

Very approximate battery costs and revenue are given in table 3, based on a battery capacity of 464kW/928kWh, over a project time-frame of 10 years. Over this time-frame, the total project cost would be on the order of $1M. For all calculations, we have assumed the network tariff is waived (DUOS = 0c), which is required to promote charging with locally generated solar energy. With a non-zero DUOS, energy arbitrage income will be lower. Note that we only included two revenue streams: FCAS (contingency) and wholesale energy arbitrage. There is the potential for revenue from network services or future new revenue streams e.g. emerging fast frequency response and virtual inertia markets.

5 Practical aspects of implementing a community battery in Jacka

5.1 Network Tariffs

Existing network tariffs are currently a major barrier for the feasibility of community-scale batteries in the NEM. For the purpose of the Jacka battery, it will be important that a discounted DUOS tariff is provided by the local DNSP, Evoenergy. The idea of discounting DUOS for local energy transport has become known as a local use of service (LUOS) tariff, and was flagged in a recent rule change proposed to the AEMC by the Australian Council of Social Services and the Total Environment Centre [14]. LUOS would apply to flows of energy that originates and terminates within a local sub-region of the distribution network. Outside of the local sub-region, the currently-used distribution use of service (DUOS) tariff would continue to apply. The introduction of a LUOS tariff would reflect the fact that transporting electricity a shorter distance is fundamentally more efficient and therefore ought to result in reduced costs for consumers.

In addition to a LUOS tariff, many DNSPs are trialling more cost reflective network tariffs e.g. a demand or time-of-use (TOU) tariff [1] and some DNSPs are trialling network tariffs that reflect demand response provided by customers [15]. Retailers will be expected to respond to this change in network tariff and pass the savings on to customers.

Caution needs to be taken to ensure we do not disadvantage customers who are not participating in a particular battery scheme. The regulatory system exists to prevent this. Rule 6.18.4 of the National Energy Rules (NER) prevents a DNSP from charging customers with similar connection and usage profiles differently. In practice, this can by waived by the AER, based on rule 6.18.1C which allows changes to tariff structures assuming it makes up < 0.5% of annual revenue and the total revenue from this tariff and related tariffs is no greater than 1%. The Jacka community battery will provide the ideal project to test whether customers who are participating in the battery scheme are ultimately paying similar network costs compared to non-participating customers.

5.2 Provision of market services

In Australia, we have a gross pool market which does not allow parties to trade energy bilaterally. Only financial derivatives can currently be traded directly e.g. power purchase agreements (PPAs). PPAs could be used for a community battery, or alternatively, the energy could be traded on the wholesale and ancillary services markets, which would require the operator to either register as a market participant or to recruit the services of a registered market participant. One option is for community-scale battery storage projects to register as a SGA for which generating units must be less than 5MW. Two dispatchable unit identifiers (DUIDs) are required; one for load category and one for generation category.

A separate market registration or registrant is required to manage FCAS trading (Market Ancillary Services Provider, MASP). Currently, the only participant who can provide FCAS from a generating unit is a registered Market Generator. Furthermore, FCAS bids currently need to be greater than 1MW, which may limit the provision of FCAS by some battery owners. Note that the fastest FCAS response (4 seconds for regulation and 6 seconds for contingency markets) does not take full advantage of battery capabilities such that the speed and flexibility of FCAS services provided by the battery are currently not fully valued (although responding faster means more capacity can be bid in some cases).

Note that, in response to a recent rule change request to address the issues of how battery storage will register and participate in the NEM [16], Tesla recommended that the SGA frame-

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[1] https://www.aer.gov.au/networks-pipelines/network-tariff-reform

work be expanded to allow small generating units to provide FCAS, as they have the technical capability to provide such a service [16]. Tesla also made the practical suggestion that the two DUIDs required for the SGA could be paired in the NEM dispatch engine (NEMDE), to avoid the need for conservative bidding behaviour [17]. Both of these suggested rule changes would positively impact community battery owners, if implemented.

5.3 Provision of non-market services, including network support

Payment for the network services the Jacka battery can provide will be critical for supporting the business case for the battery. On the NEM, DNSPs can pay for network services via specific schemes designed to promote non-network solutions relating to demand management, including the demand management incentive scheme (DMIS), the innovation allowance and via the regulatory investment test for the distribution grid (RIT-D).

For the RIT-D, a DNSP can state a need for network support (e.g. voltage management) and seek a solution by tendering on the competitive market for it. The DMIS scheme provides electricity distribution businesses with an incentive to undertake efficient expenditure on non-network options relating to demand management. The innovation allowance on the other hand, will reduce the risk distributors face with research and development costs in demand management projects that could reduce long-term network costs. Following the extreme events over the summer of 2020, AEMO is also calling for regulatory processes to consider how to better consider energy security and resilience benefits in network projects [8]. Other services that the battery could provide, but which are difficult to monetise, include increased community engagement and increased energy equity.

5.4 Technical Considerations

The Jacka community battery may require metering, integration, telemetry, and control capabilities, as shown in Figure 6. As with the operation of behind the meter virtual power plants (VPPs), community-scale batteries may need to have near real-time visibility of the connection point behaviour of participating customers. This will require the installation of new metering capabilities that are able to provide individual connection point (or customer load and generation) updates in near-real time (on the order of seconds), as shown in Fig. 6 where participating customers highlighted in red have new communications capabilities shown by the blue lines). These new metering capabilities are typically provided by low cost check meters that are installed in

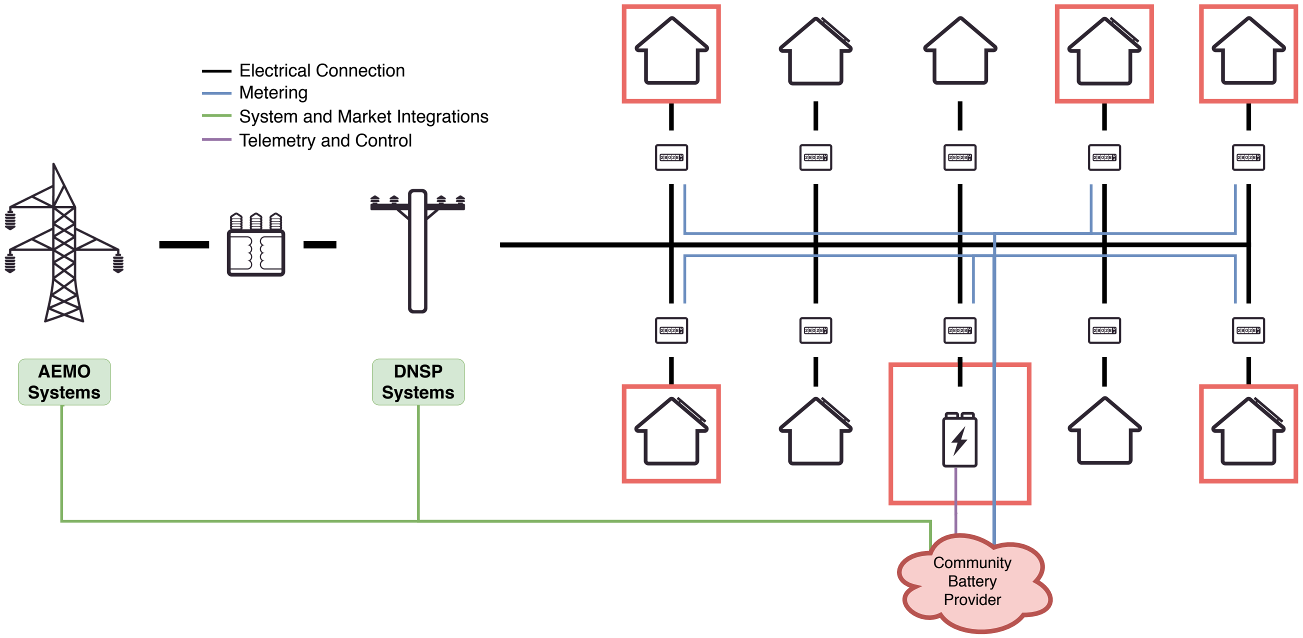

Figure 6: Implementing the Jacka community battery will require metering, telemetry, integration, and control capabilities. In this diagram the participating users in the community battery model are highlighted in red.

the premises switch board and which communicate metering data back to a cloud-based server using either the customer internet connection, or a dedicated 3G or 4G wireless connection. These check meters are typically not NMI approved meters but are equally accurate in recording electrical power flows (see e.g. the devices developed by Wattwatchers [18]).

Such metering capabilities are already available through several Australian technology providers who typically capture the data through a cloud-based platform, providing access through a web-based API where it can then be used by the community battery provider to inform the optimisation and control of the community battery. The metering may also be required to calculate the amount of local energy flows eligible for LUOS charges or to 'measure out' a subscription-based energy storage allocation as has been done in WA. [5].

To unlock the greatest possible benefits of this new metering infrastructure, it would be advantageous for the metering to allow all stakeholders (consumers and DNSPs) to view this data in near real-time. Only with this sort of monitoring will consumers, and their agents, be able to adjust their behaviour to take advantage of locally available power generation.

Specialised metering may be necessary for the community battery if it is participating in the delivery of FCAS. The technical delivery of FCAS is governed under the Market ancillary services specification (MASS) details of which can be obtained at [19]. The most obvious requirement of the MASS is the need for high speed metering that can measure the connection point power flow at an interval of 50 milliseconds or less for the purposes of auditing the delivery of the FCAS service. This differs markedly from the interval metering required for energy market participation which requires a single energy value in each market interval of 30 or 5 minutes. Should the community battery be participating in the AEMO VPP Trial [20] then alternate metering arrangements and topologies may also be valid [21].

5.5 System and Market Integration

To enable participation in AEMO-run markets for energy and ancillary services, the Jacka community battery may also require an integration with the market systems (or with an electricity retailers internal systems) and potentially integration with the internal Evoenergy systems (as shown in green in Fig. 6).

Integrating directly with AEMO-run markets is a well defined process[2], although the expertise required to navigate the process is largely limited to existing market participants. The prudential requirements can be a significant hurdle for small organisations, leading some aggregators and new market entrants to choose to work with existing market participants, rather than have to undertake these integrations directly.

Integrating with DNSP systems is often much more complex given the lack of standards to support the integration of DER. For this reason, there is a proliferation of non-standardised approaches, for example Evoenergy's IoT Hub [22]. Although many approaches are valid, it would be far better to create a unified standard for DNSP integration of DER more broadly and several initiatives are underway to try to achieve this including OPEN [3] and SDIWG [4].

5.6 Optimisation and control

The choice of optimisation and control system will need to be chosen based on the ownership and stakeholder participation model that is being implemented for the project. The relevant tariffs and services that the community battery is offering will then determine the particular objective(s) that are being optimised and controlled for operationally. The optimisation and control capabilities will need to ingest the relevant metering data from participating users (typically via a web-based API as outlined above), including the telemetry data from the community scale batteries installed in the grid. See our earlier studies for more details on how this optimisation can be achieved [3].

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[2] https://aemo.com.au/en/energy-systems/market-it-systems

[3] https://www.energynetworks.com.au/projects/open-energy-networks/

[4] https://aemo.com.au/en/consultations/industry-forums-and-working-groups/list-of-industry-forums-and-working-groups/deip-sdiwg

To support the optimisation and control of community batteries over a rolling horizon there is also the need to use solar, load and potentially price forecasts. While AEMO make some price forecasts available[5], the accuracy of these forecast prices is questionable, particularly as price volatility in the NEM has been shown to be increasing [23]. Thus far, load and solar forecasting has typically been implemented in various proprietary ways by individual market representatives and aggregators. Community battery providers may need to work with these organisations to gain access to these capabilities.

There are several Australian and international technology providers who can provide appropriate optimisation and control systems that would be suitable for operating this community battery. However, to our knowledge, the implementation of such an optimisation and control system that implements a community-scale battery operating model has yet to be undertaken in the NEM.

5.7 Management and governance

The Jacka community battery project will require governance structures to manage the following (potential) range of relationships:

1. The relationship between the battery owner and the battery operator (if separate entities),
2. The relationship between the battery owner/operator and the local DNSP. This will likely be a bilateral agreement where the DNSP agrees to pay for the provision of particular network services and the battery owner/operator agrees to provide those services.
3. The relationship between the battery owner/operator and market participants, potentially including retailers and registered FCAS providers. This will not be required if the battery owner/operator themselves registers as a market participant.
4. The relationship between the battery owner/operator and the consumers/prosumers, although this is likely to be through a retailer.

In establishing management and governance structures for battery projects, it will be helpful for organisations to consider the findings in our social research, which highlighted a lack of trust in the energy industry. Householders are likely to be sceptical of community battery models that cannot clearly demonstrate that they will genuinely benefit the local community [1].

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6 Conclusions and next steps

The results of this feasibility study suggest that a community battery installed in Jacka, ACT, could provide cheaper and more effective energy management, compared to the equivalent capacity of household storage. The greatest daily peak power reductions were achieved with community batteries on the LV network. Over half a year – best case scenario – these batteries could reduce net energy imports and exports by around 20%, for a 928 kWh battery. A rough estimate of total project costs for a battery of this capacity would be around \$1M with annual revenue up to \$370K. Note that this estimate is based on perfect foresight and likely represents the upper range of revenue that could be expected.

It will be important to ensure that the battery owner and operator will operate the battery to benefit all stakeholders e.g. Jacka householders, the battery owner, *and* the local network operator (Evoenergy). Establishing a working relationship with the local DNSP (Evoenergy) will be crucial to establish and manage the battery project moving forward, ensuring it provides the maximum benefit to the network possible.

The Jacka community battery would be the first to be implemented in a greenfield development site in Australia and therefore offers an opportunity to test innovative ideas, particularly around customer participation models. This demonstration project will enable the sector to understand the logistics of operating a community battery on the NEM and to understand the benefits that could emerge from the at-scale adoption of community-scale batteries, as a complement to residential and utility scale battery storage to power our electricity grid into the 21st century.

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