Local Battery Feasibility Study for Venus Bay and Tarwin Lower

Prepared for Energy Project Partners:

VENUS BAY COMMUNITY CENTRE

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CHANGING WEATHER

Ethical Fields

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About the Venus Bay Energy Project

The twin communities of Venus Bay and Tarwin Lower will spend 2022 and 2023 investigating energy options for a resilient community with reliable energy. This project has been funded under the Federal Government's Preparing Communities scheme.

A community-centred design approach has been used to identify key elements of resilience from the perspectives of residents, business owners, holiday makers and critical organisations, e.g., State Emergency Services.

The outcomes of the first two workshops can be found on the Venus Bay Community Centre website: www.vbcc.org.au/communityenergy

The project has identified a range of critical sites and small clusters of sites that should be prioritised for energy supply during outages and emergencies. This report provides the analysis of battery feasibility for each cluster.

Purpose of this report

This report has been developed as a preliminary assessment of options for batteries at priority sites in Venus Bay and Tarwin Lower.

It aims to:

- Identify feasible technical options and designs at each site.
- Identify commercial considerations and economic feasibility at each site.
- Identify the ways each battery can deliver benefits to the Venus Bay and Tarwin Lower community.
- Identify a strategic approach for rolling out storage across the community over the longer term and therefore the key learning that must be obtained during the initial tranche.
- Identify outstanding considerations that need to be explored and developed in conjunction with community stakeholders in the course of full business case development.

Venus Bay has 1,950, almost entirely residential electricity customers and the older, adjacent town of Tarwin Lower has around 300. The majority of the community buildings and the commercial service infrastructure that the community is reliant upon is based in Tarwin Lower. A small permanent population is boosted by significant part-time residents on weekends and visitors in holiday season when the population can swell to over 8,000 people.

31 December 2021 – Grass Fire Isolates Venus Bay

The battery designs in this report all prioritise the delivery of power during outages and emergencies. The fire on 31 December 2021 demonstrates the community vulnerability. For around 7 hours, residents were unable to leave Venus Bay if an urgent need arose. Those in the cars photographed below were unable to return to their homes.

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Executive Summary

The feasibility of four neighbourhood batteries are assessed in this report. The report forms part of a suite of activities and investigations underway as part of the Venus Bay and Tarwin Lower community resilience and reliable energy study. The four locations and applications have been prioritised through community workshops and engagement and based on the values and local evidence presented by the community.

It is impossible to say batteries will be profitable at this stage. They don't exist in a vacuum, but rather form part of a system. All players in the community-scale battery space are still learning about ways to streamline costs and still deliver value back to communities. The value captured by various parties in the electricity system does not always return to battery projects in the form of premium revenues.

Our assessment recommends that the community of Venus Bay and Tarwin Lower applies for a business case grant to develop the business models that will deliver these four projects. We have identified the key reasons for trialling batteries at the four sites and the learning that needs to flow from the projects.

A summary of our recommended battery designs are:

1. A 100kW/300kWh battery is recommended for the shops and 75 homes on the Jupiter Centre feeder in the centre of Venus Bay with a target cost of $367,000. Growth in solar production on the feeder of 120kW should also be targeted and a campaign to shift hot water and other flexible loads to times of solar surplus should also form part of the project. If the battery charges only from surplus solar energy it will cycle with a 37% duty[1]. It will shift 40 MWh per year from low value to high value times. If 40c/kWh uplift in value can be achieved on average, this will generate $16,000 per year in revenue or savings.

2. A 60kW/150kWh battery is recommended for the recreation reserve, school health centre and 47 homes on the Tarwin Lower 94 feeder with a target cost of $242,000. Growth in solar production on the feeder of 80kW should also be targeted and a campaign to shift hot water and other flexible loads to times of solar surplus should also form part of the project. If the battery charges only from surplus solar energy it will cycle with a 58% duty. It will shift 30 MWh per year from low value to high value times. If 40c/kWh uplift in value can be achieved on average, this will generate $13,000 per year in revenue or savings.

3. A 50kW/100kWh battery is recommended for the Cantor Fishermans feeder in Estate 2, located near the fishing club and servicing 67 homes with a target cost of $203,000. Growth in solar production on the feeder of 110kW should also be targeted and a campaign to shift hot water and other flexible loads to times of solar surplus should also form part of the project. If the battery charges only from surplus solar energy it will cycle with a 61% duty. It will shift 22 MWh per year from low value to high value times. If 40c/kWh uplift in value can be achieved on average, this will generate $9,000 per year in revenue or savings.

4. A 100kW/300kWh battery is recommended for the Venus Bay 2 feeder on the main street of Tarwin Lower which services the petrol station, the fire station, the telephone exchange and tower and the IGA with other shops. A cost of $367,000 should be targeted. Growth in solar production on the feeder of 200kW should also be carefully located to optimize savings for businesses and flexible loads

[1] 100% duty is equivalent to one full cycle daily, although some batteries cycle twice a day.

should be explored – needing customised solutions based on business energy use. If the battery charges only from surplus solar energy it will cycle with a 45% duty. It will shift 50 MWh per year from low value to high value times. If 40c/kWh uplift in value can be achieved on average, this will generate $19,000 per year in revenue or savings.

A further $22,000 per year in value has been identified as a result of more reliable energy supply. This value is not monetised but for a community that suffers frequent and sometimes extended outages, the value is real.

Community Values – linked to Battery Operation

Community Values around energy supply have been developed across the first two Workshops of the Community Resilience and Reliable Energy Feasibility Study. Full reports from each Workshop are available on the project website[2].

Workshop 1

The first Workshop highlighted the interrelationships between energy supply and other critical infrastructure. Telecommunications and access to water and sewage featured prominently. Importantly, relationships to groups and community buildings are also key features of a resilient community and critical services are not always linked to specific locations.

The Workshop results were augmented with an additional survey throughout the community and events at the Venus Bay Community Centre and the Tarwin Lower markets.

Rankings across the categories of *Essential*, *Enough* and *Everything* have been used in this report to assess the minimum level of service that is desirable (Essential) and the frequency of events when the community would be restricted to only servicing its Essential needs. For example, a battery when augmented with local solar energy might be able to operate for many days in succession during sunny weather but offer restricted service during stormy weather or when solar panels are impacted by bushfire smoke.

The categories have been adapted from NREL[3] and the guidance provided to community members is shown in Table 1 below.

Table 1 Understanding Energy Criticality

Level	Category	Consequence
0	Everything	Future proof, enhancing community well-being
1	Everything	No impact to minor annoyance
2	Enough	Annoyance but alternatives exist
3	Enough	Annoyance but no alternatives exist
4	Essential	Major annoyance or monetary loss
5	Essential	Health / Safety risk, Major loss

The ranking of services by over 100 community members is shown in Figure 1. This data has been used to convert the load profiles in each location two three distinct load profiles – Essential needs, 'Enough' which would cover most requirements and the discretionary energy uses that bring the load profile back to 'Everything'. There is nuance in all energy use that cannot be captured by these metrics. Ability to manage

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[2] https://www.vbcc.org.au/communityenergystudy Workshop 1 Harvest Report and Workshop 2 Harvest Report
[3] Fei Ding, *NREL,* Grid-Edge Energy Resources to Shape Resilient Community Microgrids slideshow

without electricity is often predicated on other capability and resources, especially access to backup fuels like LPG for cooking. Over longer durations, more energy needs become critical.

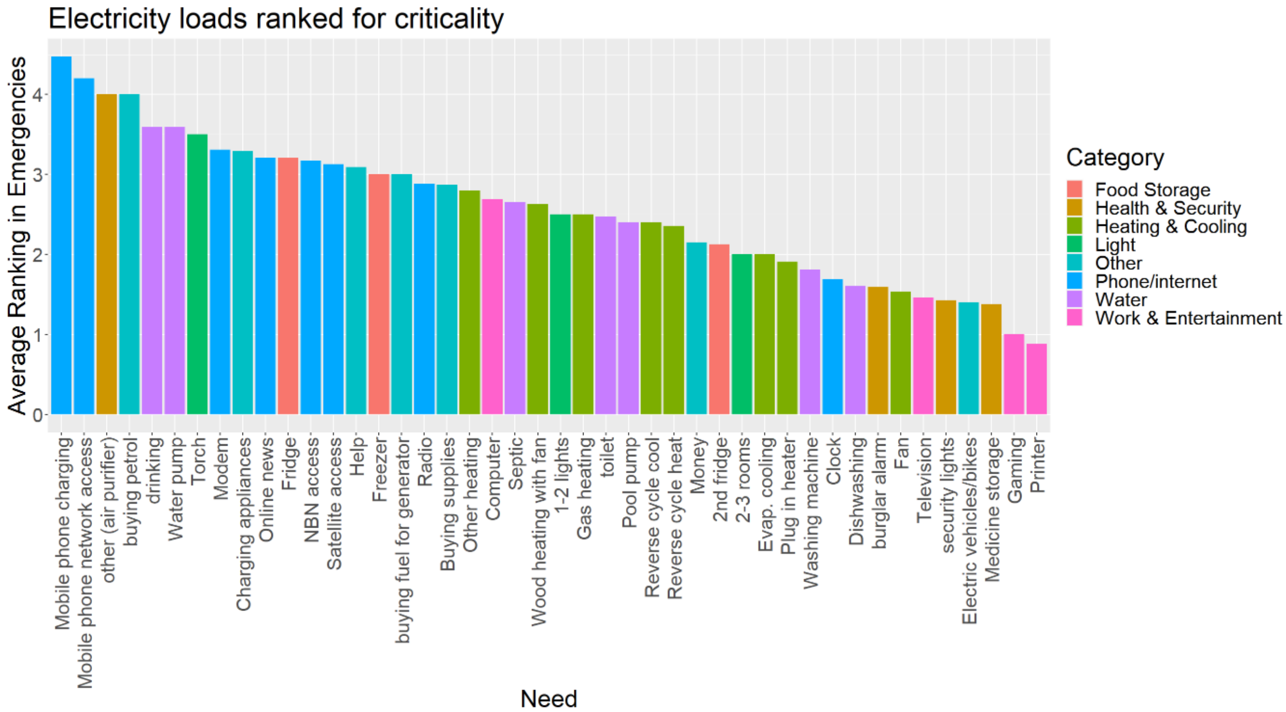


Figure 1 Electricity priorities ranked by Venus Bay and Tarwin Lower communities

The technical team has calculated the essential electricity needs at approximately 25% of total electricity consumption. A sample of the three load profiles is given in Figure 2 for the residential feeder known as "Cantor Fishermans" in Estate 2.

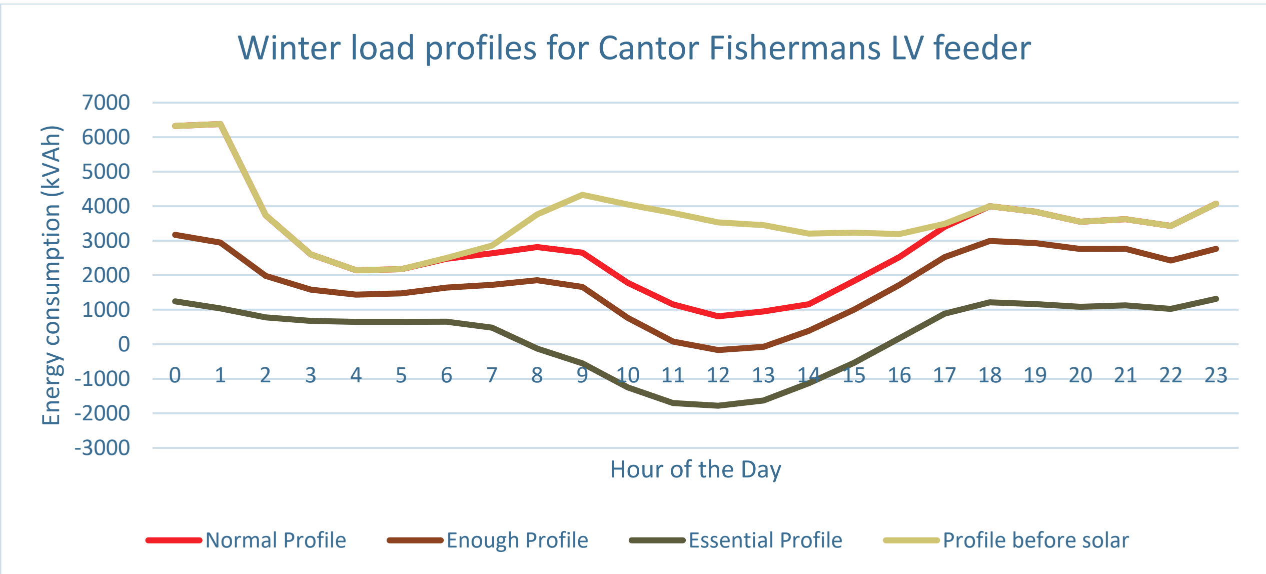


Figure 2 Demonstration of Essential, Enough, Everything

This feeder is also one of the four key sites chosen for business case development. The assumptions that underpin the development of each load profile are recorded in **Error! Reference source not found.**.

Table 2 Breakdown of electricity consumption

Residential Load Component	kWh/ day	Essential %	Enough %	Rationale
Whitegoods – fridges, freezers, washing machine, dishwashers and dryers	1.86	100%	100%	This will be heavily slanted toward fridges because many homes are unoccupied during much of the year but fridges are likely to remain on.
IT and Home Entertainment including modems, antennas and telephones	1.21	50%	100%	Modems, mobile phone charging and computers for work were all rated as essential. This category includes many leisure uses of IT equipment as well.
Lighting	0.71	20%	80%	Lighting consumption is easily manually controlled and reduced
Cooking – electric ovens, microwaves, kitchen appliances. 40% of cooking is estimated to be LPG based.	0.78	50%	80%	Cooking incorporates many appliances and involves choices that can be modified when necessary. Many will have access to a LPG BBQ.
Heating and Cooling – this represents a mix of plug in heaters and reverse cycle airconditioning. 10% of the heating is estimated to be based on wood.	2.88	10%	80%	Heating and cooling is a singular large load that could easily compromise an essential services system. In some circumstances, inability to heat and cool adequately, poses a health risk.
Other – pumps and sewage systems were estimated	2.56	25%	75%	Sewage systems can be turned off because that is what would happen during an outage. Tap water and flushing can be used sparingly. Drinking water can be stored.
Transport & Water Heating – many people still use other fuels for transport (99% petrol) and hot water (50% LPG) so consumption is lower than it will be in future.	3.74	0%	25%	Hot Water systems and electric vehicles have innate storage capacity and therefore can be turned off to wait through essential moments.

The data collected to assess household needs has been investigated in some depth but only limited information has been gathered to date about commercial constraints facing all the shops across both Venus Bay and Tarwin Lower. The IGA supermarket in Tarwin Lower runs its own generator during outages. The general store in Venus Bay has recently invested in a backup generator. This is a reflection of the losses that can be incurred during extended outages. Both sites provide the bulk of fresh food that the community relies upon, and food spoilage is not only a commercial concern for the supermarkets. It is also a concern for the food and hospitality businesses located nearby and the community at large, including large numbers on visitors that might find themselves reliant on these sources of food. Food is only one example of the way resilience, essential needs and the benefits of reliable electricity supply is expressed in the relationship between the community and the commercial businesses and community organisations that provide services to the community.

Recommendations:

Further insights into essential levels of electricity consumption at the identified community buildings and shops will need to be part of any further battery business case development.

The assumptions that underpin the development of 'essential' and 'enough' load profiles, and their reflection in battery sizing decisions need testing with community members who have taken time to understand the interactions of batteries with energy use behaviours.

Workshop 2

At the second Workshop participants developed an understanding of the values that would guide the design of energy solutions in Venus Bay and Tarwin Lower. The ultimate aim of the energy project is to demonstrate a pathway to resilience, reliable energy and self-sufficiency. The ability to operate when the main grid is not available, ie to operate in microgrid mode, will rely on any site, cluster or community boundary to include:

- Adequate Generation
- Adequate Storage
- Adequate Control
- A defined disconnection point and boundary

This feasibility study focuses on identifying what "adequate storage" will mean when striving to fulfill the values identified by the community. The ranking of values is shown in Figure 3 below and is based on participant engagement at the workshop, follow up engagement at the Tarwin Lower Markets and an online survey.

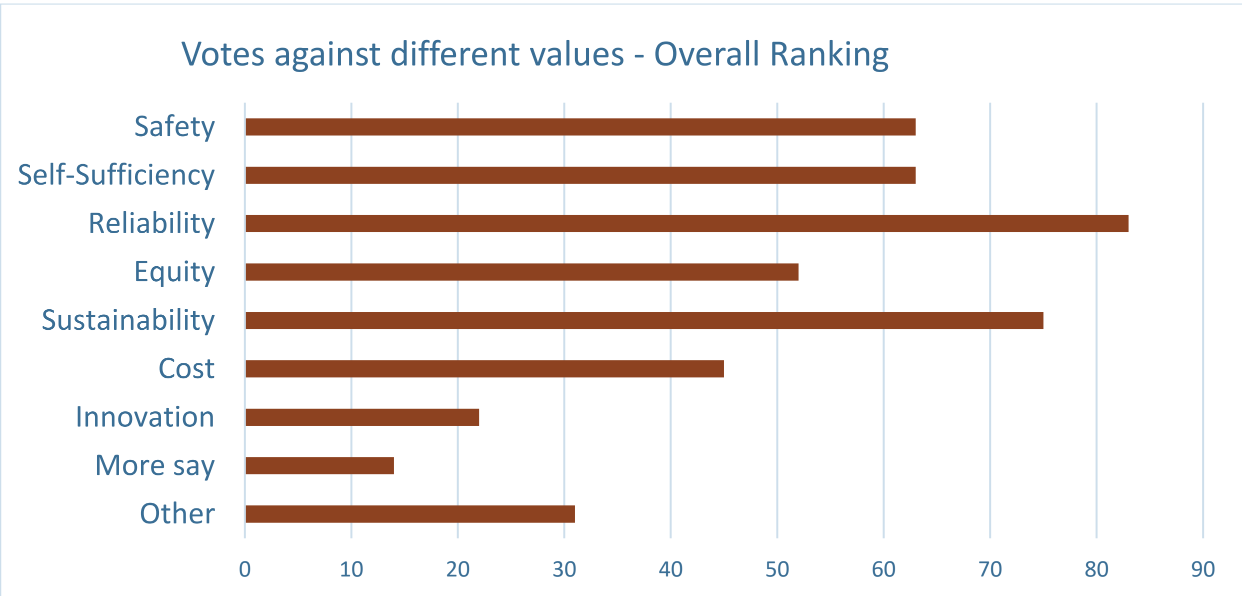


Figure 3 Community Values for local energy solutions

Participants described these values as follows:

Safety for us is ……..

- safe places for people to go during outages as a priority
- at personal and community levels
- Critical for keeping communications channels powered up during emergencies e.g., bushfire,
- Providing power for medical needs
- Pumping water for drinking and other uses
- choosing batteries that won't combust or cause fires
- prioritising communications for essential services
- relief and recovery hubs = Centre of Resilience
- Electrical system safety

Self-sufficiency for us is ……

- localised
- a process involving community
- connected to reliability
- separation from big profit driven companies
- having control and say about our energy
- Inclusive of economic benefits for us and government,
- Being smart about not using so much energy,
- putting power of decision making on energy back in community
- A strong community value
- Having a microgrid

Reliability is ……

- resilience
- Strongly related to self-sufficiency,
- crucial as it influences quality of life
- important when prioritising placement of energy systems at sites, clusters and whole-of-community
- Energy that works no matter what
- Accommodation of a fluctuating population
- The ability to support small clusters so a break in the line doesn't affect everyone down the line,
- secure energy supply in at least one place in each large cluster,
- important for businesses and food safety & security, petrol, post office

Equity is ……..

- related to cost
- Involving of the whole community (locals, businesses, groups, visitors)
- Not limited by geography
- Possible ownership of the grid
- supporting everyone in community
- About sharing power and fair usage
- When people with medical needs are prioritised
- Visionary
- When finance & ownership models deliver multiple benefits

- Accessible and inclusive of full-time, part-time, visitors, businesses and community groups

Sustainability is …..

- Inclusive of cost – "if it's not cost effective, it's not sustainable",
- it is 'renewable' energy,
- helping us move away from fossil fuels,
- environmentally friendly, I
- Technology that is reusable or recyclable
- being prepared to link to wind energy,
- long lasting technology, going many days without grid power
- scalable to suit essential needs,
- keeping size & scale low will have positive impact on sustainability,
- Protective of the environmental
- About leadership

Cost……

- Is included in self-sufficiency
- Takes into consideration upkeep
- Includes selling excess power to earn an income that helps pay for upkeep
- Is about lowering energy bills and impacting positively on cost of living
- Effectiveness of each component
- keeps domestic bills down,
- Is reduced by government investment
- Needs to consider scalability and add-ons to enable cost comparisons,
- includes adaptability and open source,
- Encourages living simply and using less

Innovation is …..

- less important for our communities, but we can help lead the way for others and be role models for other end-of-line communities
- we can learn from and improve on what's come before
- integrating future tech like electric vehicles, Wi-Fi transmission
- evident in systems that adaptive, modular, replicable and emerging technologies
- Seen in equity models that cover essentials needs first then enough and everything
- how we can get more control over the grid
- Our opportunity to be leaders because we have been left behind

More say is ……

- included in self-sufficiency,
- Influencing flexible or community feed-in tariffs
- buy-in of non-residents too
- our energy future
- continued engagement of people in the study and the plan as it's rolled out,
- encouraging others to have more say by role modelling how community can lead in the design and decision making

Other values and considerations ………

- Community building
- Collaboration
- Who runs it/owns it/maintains it/covers insurance,

- location needs to not damage peace and tranquility of our landscapes or be divisive to our communities,

These values influence battery sizing and design as follows:

Safety reflects the challenges of emergency situations. This goes beyond the role of Ausnet services because major events are excluded from the regulated performance standards. Emergency generation and backup power is normally seen as a private investment decision. It closely tracks the category no. 5 in Table 1 above because emergency management risks with unacceptable losses have been traditionally solved with a generator investment.
A local battery can provide some backup power. Unlike a generator, the length of time for which it can provide emergency generation will be curtailed by the initial investment decision. Some backup generation to complement a battery investment is likely to be worth including in the design. The balance of each investment is a key design decision.
A proposed safety metric is to identify the number of people that can access safe places with energy during emergencies. Venus Bay and Tarwin Lower do not have any official safe places, so in some emergencies people will be expected to leave. At other times, the idea that batteries will serve a wider community means that sizing will need to focus on increased needs, as more people than normal come to use the energy service provided by the battery. Again, should such rare occurrences endure for longer periods, a backup generator will be a complementary asset.
Further issues identified by the community description of the value "safety" are:

- Ensuring powered sites can provide all the services identified, particularly water, telecommunications and medical needs.
- Choosing robust technology with safe installation and location choice.
- Potentially limiting battery technology choices to non-combustible options.

Self-sufficiency can be achieved with adequate storage to complement, adequate generation and control. Using only a battery to manage the mismatch between generation and energy use is an expensive proposition that undermines the financial sustainability also needed to support any self-sufficiency proposition. Sizing a battery for self-sufficiency therefore requires a holistic approach that includes energy efficiency, load shifting and load flexibility. From a behavioural perspective, self-sufficiency can also be driven by good feedback and information about levels of self-sufficiency that are being achieved and active choices to manage energy differently for rarer occasions when generation capacity and storage capacity are inadequate.
A proposed self-sufficiency metric is the proportion of local energy use that is served directly by local energy generation and storage.
A further element of self-sufficiency identified by the community is around the decisions about ownership, operation and economic benefits. The self-reliance that has been identified as a traditional community value is undermined by an increasing dependence on electricity and the digital technologies and telecommunications that also depend on electricity. In future this will include reduced levels of alternative fuels and dependence on electricity for transport as well. The business model proposals in this study explore options for self-sufficiency in the commercial design of the battery.

Reliability of electricity supply in Venus Bay and Tarwin Lower is below average. The performance statistics of Ausnet services, the network provider, are covered in further detail in the next section on essential energy needs. If safety (above) is the value that best captures resilience, extreme events and emergencies, then reliability is the energy response that improves welfare by reducing the day-to-day inconveniences of outages

– planned and unplanned and mostly of shorter durations. We are in the midst of a transition to new technologies like batteries and electric vehicles so learning about the best mix of storage assets, both private and communal will take time. A local battery in Venus Bay and Tarwin Lower will help households, businesses and Ausnet Services all learn about getting the mix right.

A proposed reliability metric is the proportion of outage time that is reduced by local backup power. The benefits of making this power available to the wider community, of prioritising essential energy use and critical services and the proportion of residents and visitors that avail themselves of the service may also need to be estimated and ultimately measured.

The vulnerability that is designed in or out of the system is a further consideration. A few kilometres of electricity network separate Estate 1 from Estate's 2 & 3, and in the other direction, from Tarwin Lower. This suggests that systems in each Estate will offer more reliability than a community-wide system.

<u>Equity</u> demands that any investment is prudent, returning good value for money and not leaving the community with a burden for operation and maintenance. It also seeks to allocate energy and value to the highest needs and as widely as possible.

Equity metrics will need to cover two concerns:

- Reducing costs, which is unlikely from the battery investment alone but could be developed by innovative ways of allocating benefits to drive longer term cost reductions in areas such as access to solar, energy efficiency and use of surplus solar.
- Increased access. This would allow the community to understand the impact of service availability beyond energy. Eg Telecommunications, provisions from the shops, serving medical needs, improved comfort from energy efficiency, access to renewable energy etc. It would also build understanding about who needs improved access, particularly the visitor population who don't expect outages and the vulnerable population.

<u>Sustainability</u> measures more than just renewable energy. Further discussion will be required to understand how procurement and design approaches can ensure a positive impact on the environment, can best maintain the beauty and peacefulness of the location while also enhancing the brand of Venus Bay and Tarwin Lower as a destination.

Two proposed renewable energy metrics are the proportion of renewable energy (including heat and transport) used and produced in the community.

Sustainability also covers the transition away from fossil fuels and toward a future that is not fully clear at the moment. The learning and progress that prominent local batteries can encourage should also be considered.

<u>Cost</u> has been captured somewhat within the value of Equity. A further consideration that has been included in the strategic approach (see section on site comparisons) is the longer term scalability, repeatability and learning that can be developed during an initial implementation of four batteries.

<u>Innovation</u> is at the heart of the energy project. Venus Bay and Tarwin Lower have shown a willingness to lead and experiment in crafting unique solutions for this community. Showcasing the community progress, and sharing the lessons is all part of the commitment to proactively shape the future of this community.

<u>More say</u> is closely related to self-sufficiency. The assets within community control will only increase as part of this project. The partnerships that allow local governance to integrate with the electricity network governance and local council have already been enhanced over the course of this project.

Recommendations:

The following issues have been identified in community engagement to date but are beyond the scope of this report and should be included in future battery assessments:

Metrics for reflecting performance against each value need to be tested and refined further with the community. Many issues raised by the community are qualitative and lend themselves to a policy that guides further work. Metrics associated with equity and sustainable procurement and design are still to be developed.

A risk of providing battery-based energy services is that people will stay in the community during events when it would be safer to leave. Communications and planning around this scenario need to be conducted with emergency planning personnel from Council and emergency services.

The price premium for battery technologies that are non-flammable has not been investigated. The management of safety risks for different technology types would benefit from a more fulsome comparison that should be carried out during any tender process, with independent analysis to complement information provided by manufacturers and installers.

This study identifies possible business models but full commercial arrangements will need to be developed with community stakeholders. Investors, users and beneficiaries can all be distinct groups and the governance to manage battery operation, revenues and allocation of benefits should only be defined with the support of those involved.

Ausnet Services should be invited to partner in any subsequent work. Regulatory barriers may mean that Ausnet's contribution to local reliability and long-term local capacity cannot be recognised formally but acknowledging the contribution of a local battery can be an important step that enhances learning at the regulatory level.

The community value statements should be revisited at the start of any future work to ensure that all issues identified have been considered and adequately incorporated to ensure that final designs capture community ambition.

Relationship between values and battery operation

The battery design is based on a number of choices in which community values can lead to conflicting priorities.

- The battery capacity in kW
- The battery duration (or energy capacity in kWh)
- The technical design and cost
- The battery charging regime
- The battery discharging regime

A battery will serve as many values as possible (creating what is known as a 'value stack') and the design will prioritise some values over others when there is conflict. Cost and value is an ever-present trade-off. There is always a cost-limit at which there may be better ways to serve a value, eg safety, than ever-increasing investment levels.

In Venus Bay and Tarwin Lower the top 5 community values defined above guide battery design as follows:

Safety

- Capacity: sized to meet peak demand
- Duration: sized to last for multiple days in poor weather with low solar top up or augmented by a generator
- Technical attributes: Robust and high reliability. Safest chemistry available.
- Recharge immediately after an event from any source
- Discharge only during an event. On standby for an event at all other times
- Duty: light, occasional

Self-sufficiency

- Capacity: sized to meet demand that cannot be served by solar and flexible load
- Duration: sized to work hard most days, shifting surplus to peak need
- Technical attributes: readily available with replaceable parts and ease of operation with local skills – open source.
- Recharge to reduce the surplus solar that is wasted
- Discharge to serve needs that can't be served by energy efficiency or load flexbility
- Duty: moderate to high

Reliability

- Capacity: sized for likely demand during an outage, noting that sizing for peak essentail demand would be adequate in most cases
- Duration: sized to last for multiple days in most conditions, noting that reducing demand served or complementing with a generator are both options for extending battery duration
- Technical attributes: Good reliability with ease of repair with local skills when required.
- Recharge soon after discharge with surplus or low cost energy
- Discharge in the higher value periods immediately before recharge opportunities so that battery spends most of its time available for reliability duties
- Duty: moderate

Equity[4]

- Capacity: Value for money, which means capacity is likely to be sized at minimum underlying load so that all capacity is used
- Duration: sized to work hard every day, shifting surplus to peak need so the duration might be minimum night time load or minimum premium load in the 3pm-9pm high value window

[4] much of the equity value is served through allocation of benefits which can be managed through the business model and treated separately from technical design and operation

- Technical attributes: Best value for money. This sector is learning so equity could also mean replicable choices with reliable providers
- Recharge with cheapest and lowest value energy
- Discharge to displace the highest cost energy
- Duty: high

Sustainability

- Capacity: sized to reduce or eliminate surplus solar at peak export times
- Duration: sized to shift to most solar possible to fossil fuel times
- Technical attributes: environmental impact of technology/chemistry along supply chains and through end of life considered.
- Recharge to reduce local surplus solar that is wasted and cheap wind when capacity available
- Discharge to displace energy uses that would be otherwise served by fossil fuels
- Duty: moderate to high

Recommendations:

Battery design will try to serve as many values at the same time and there will be trade-offs. Further work is recommended to show stakeholders how different battery design and operation will lead to different value generation.

A flexible approach to battery design is recommended so that the community can learn how well it serves the values articulated and modify operation or extend battery use as the project develops.

Providing Safety, Reliability and Resilience by Serving Essential Energy Needs

Venus Bay and Tarwin Lower are within a priority region for bushfire risk according to the Federal Government's identification of priority locations. In addition Venus Bay has single road access to 1950 homes on a narrow peninsula making it a particularly vulnerable community. Fires, or channel flooding across the access road, can easily leave the Venus Bay community isolated and residents unable to depart from Venus Bay. It can even separate Estate 2, further up the peninsula, from Estate 1.

The community relies on electricity supply via a single line from Inverloch (see Figure 4) which frequently fails due to its susceptibility to bushfires, storms and high winds. In response to the 2009 Victorian Bushfires Royal Commission recommendations, Ausnet Services is now required to isolate some parts of the electricity network during bushfires. This means Venus Bay and Tarwin Lower's power supply is more likely to be deliberately disconnected on days of high fire danger, even if the risk is distant from the community.

LPG (bottled gas) also supplements energy supplies in the community. A single petrol station in Tarwin Lower is the only source of transport fuel.

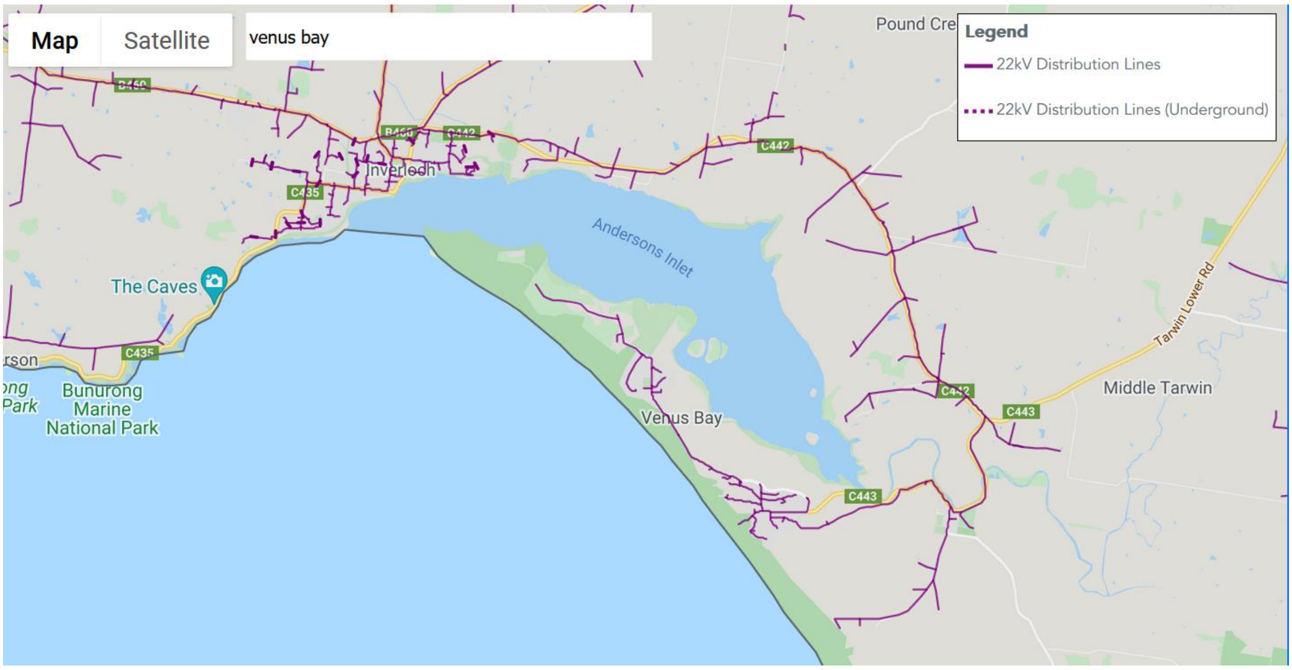


Figure 4 Medium voltage network serving Venus Bay (from Ausnet Rosetta portal)

Network Performance – Ausnet statistics

The Venus Bay and Tarwin Lower community is the main population served by WGI24, the medium voltage feeder from the Wonthaggi Zone Substation. Of the 3,700 customers on WGI24, 1950 reside in Venus Bay and almost 300 in Tarwin Lower. The whole region faces energy consumption pressure during summer holidays to the extent that diesel generators and now a battery at Philip Island are used to relieve pressure on the Wonthaggi Zone Substation.

WGI24 is classified as a "short rural" connection and Ausnet targets can be seen in the middle column of the table below.

Table 3 Ausnet latest performance targets

1 July 2022 – 30 June 2023 (FY23)	Urban feeder	Short rural feeder	Long rural feeder
Average minutes off supply per customer (unplanned power outages)	87 mins	195 mins	294 mins
Average number of supply interruptions per customer longer than 3 minutes (unplanned power outages)	0.89	2.01	2.63
Average duration of an unplanned customer interruption +	98 mins	97 mins	112 mins
Average number of momentary interruptions per customer less than 3 minutes (unplanned power outages)	2.82	5.66	9.92
Average minutes off supply per customer (planned power outages) *	101 mins	163 mins	237 mins

The statistics for 2020/2021 show a particularly dire year for Venus Bay and Tarwin Lower residents with almost 45 hours of outages in the year compared with 4-20hrs in previous years. There are additional considerations. The statistics are averaged by every customer on the feeder but if the faults on the network disproportionately occur between Tarwin Lower and Inverloch then this figure understates the impact on Venus Bay and Tarwin Lower customers by 60% so the local outages could have been as high as 74hrs. Figure 5 below demonstrates this phenomenon by analysing the outage data for different cohorts of customers on the feeder.

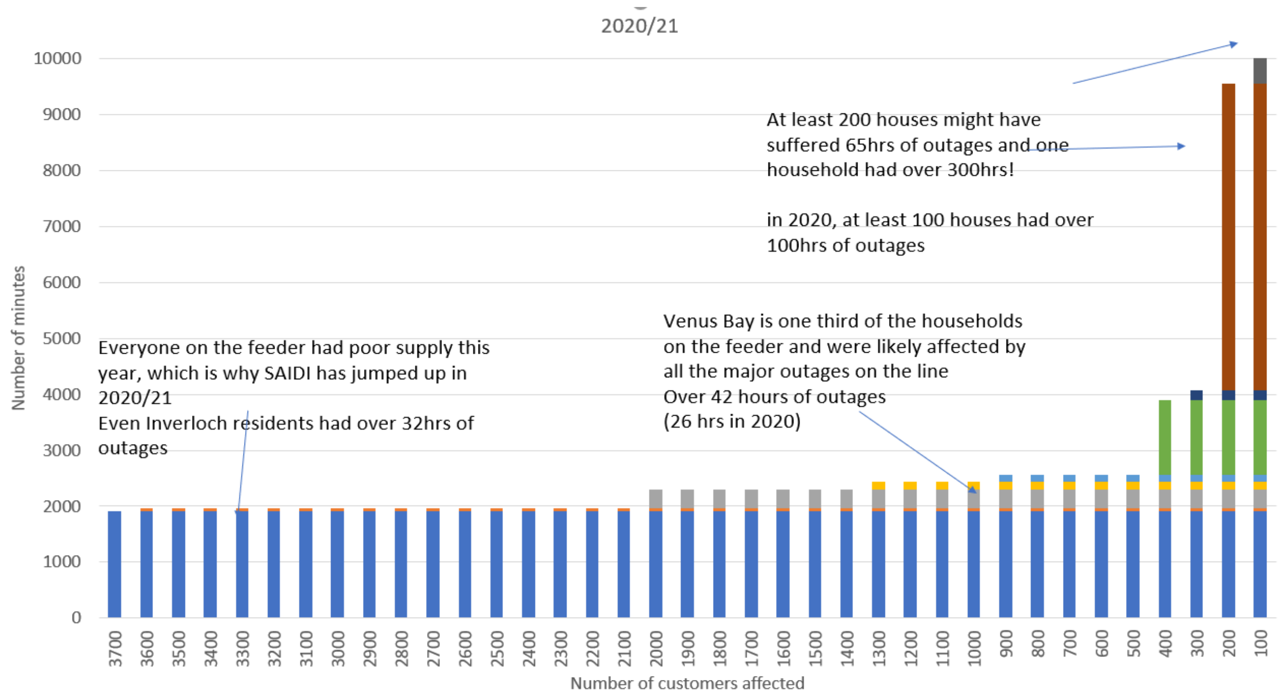


Figure 5 Impact of outages against different numbers of customers affected each time

The Ausnet target does not include a variety of challenges that are out of the control of the network provider and these are declared major event days – eg significant storms. This is no solace to a community without power. The regulator expects that Ausnet will focus its efforts on a) reducing outages for the largest number of people and b) upgrading performance on feeders with its worst served customers. Venus Bay and Tarwin Lower are not considered a priority case since they do not constitute large populations compared to some other parts of the Ausnet network and they are poorly served but not in the top ten for worst served. Figure 6 shows this comparison.

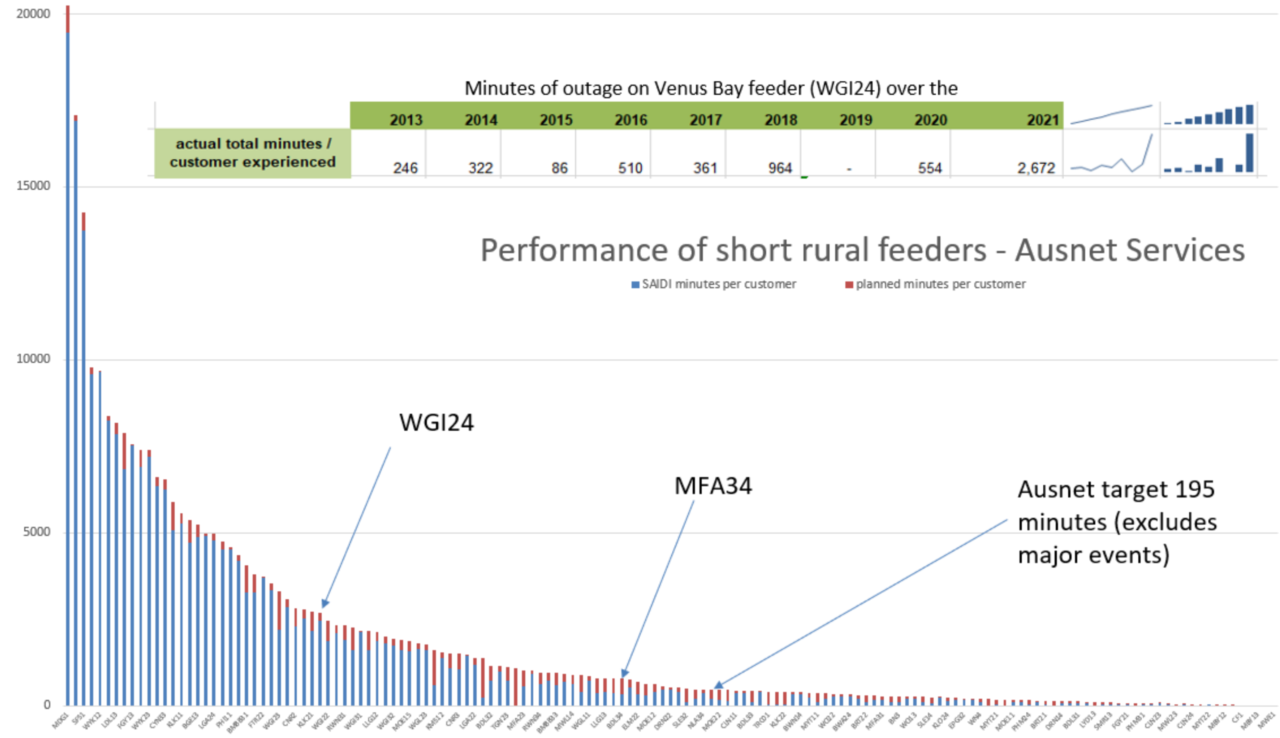


Figure 6 Comparison of Ausnet Short Rural feeders

Ausnet is incentivised to reduce the amount of time that large numbers of customers are affected by outages and the regulated price for this reduction is known as the Value of Customer Reliability. It places a value of around $22 on every kWh extra that a customer can have to avoid facing an outage of up to 12hrs. Longer duration outages are seen as a special case because the impact of an outage has a high value if the outage can be eliminated and the difference between 1hour and 2 without power is more than the difference between 11hrs and 12. In reality this measure tries to reflect both high value and low value needs and both critical and non-critical customers so it is imperfect. (Although some additional measures capture the impact on very large businesses, which are expected to place a higher value on reliability). The measure is used to guide investment by the electricity networks. Ie if an investment can reduce outages at less than $22/kWh over its lifetime, then it is encouraged.

For comparison 20 hours of outages in Venus Bay and Tarwin Lower would normally provide 13,000kWh and if they could be eliminated and this has a value of $290,000 to the community.

Each battery in this study uses the 20hr x $22/kWh metric as one additional value added for reliability. 20hrs has been chosen because the performance of 2021 appears to be an outlier. 2019 data is missing. The metric has only been applied to an assumed essential load of 25% of full load to avoid overstating the value. This is still an imperfect approach and provides significant value that is not monetised in any way. Alternative measures may emerge as the full energy project progresses.

Energy Project Scales

The Community Resilience and Reliable Energy Feasibility Study considers all scales of energy supply:

- Individual sites
- Small clusters of sites already electrically connected via sharing the same low voltage feeder and transformer
- Larger clusters across the three main residential estates in Venus Bay and for the whole town of Tarwin Lower
- The whole community which relies on a long feeder from Inverloch

In Workshop 1 participants developed a map of the community and the key connections that support community resilience. The map recognises that people and infrastructure are all reliant on energy and can all be connected through key community sites and organisations.

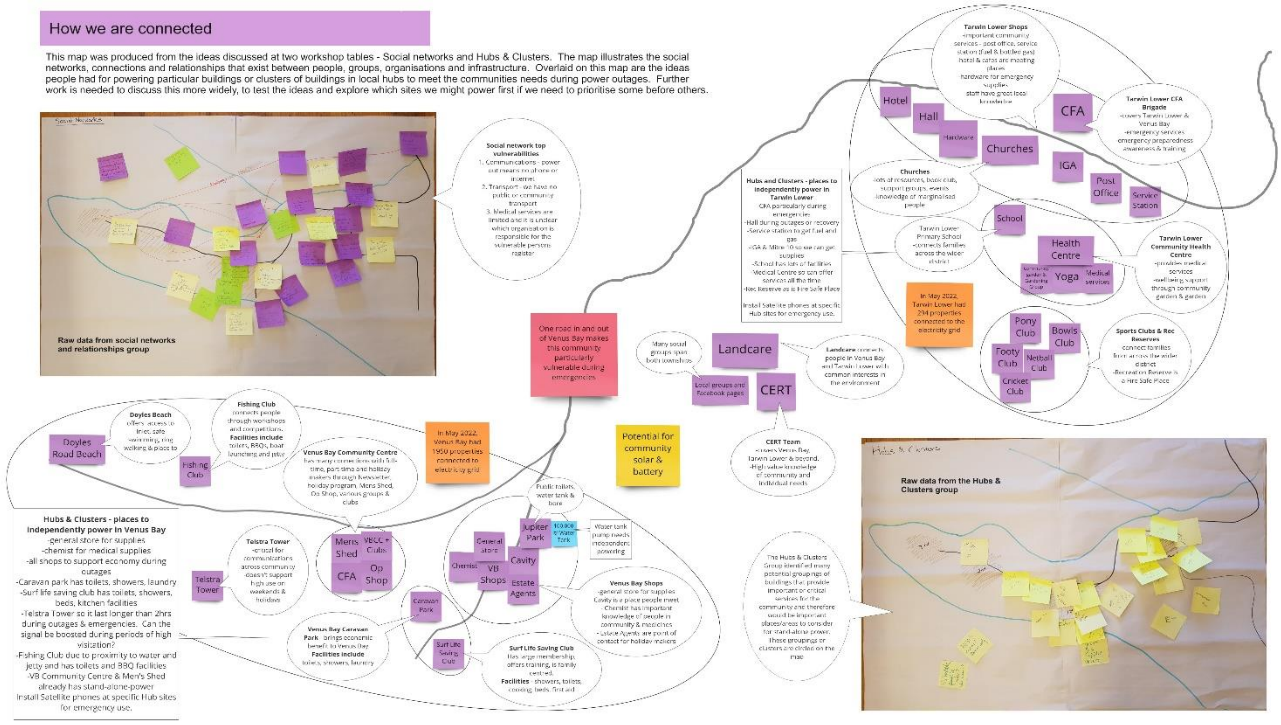


Figure 7 Identifying key connections for resilience

Comparison of Shortlisted Sites and Clusters

The mapping exercise allowed the project team to identify the community assets that were most highly valued by the community in terms of contributing to community resilience.

Most of the communal infrastructure in terms of shops and community buildings, and including the mobile phone tower and telephone exchange have been identified across 10 Low Voltage feeders. The remaining 32 feeders and a SWER line are almost purely residential. These key feeders are compared in the table below.

Feeder Name	Description of services	Transformer Capacity	Customers Total, resi	Solar PV and restrictions
JUPITER CENTRE	Venus Bay shops, general store, chemist, food outlets	315 kVA	95, 75 homes	61kW solar, restricted exports, 185 kVA peak demand[5]
TARWIN LOWER 94	School, Recreation reserve, health centre and clubs	315 kVA	55, 47 homes	109kW solar, restricted exports, 106 kVA peak demand
CANTOR FISHERMANS	Fishing club, BBQs & public toilets	315 kVA	68, 67 homes	38kW solar, 101 kVA peak demand
VENUS BAY 2	CFA, IGA, Petrol station, Post office and shops. Tarwin phone tower	500 kVA	18, 2 homes	81kW solar, 112 kVA peak demand
CANTERBURY CONSTANCE	Telstra tower, Optus service, transfer station	200 kVA	59, 56 homes	54kW solar, 75 kVA peak demand
Caravan Park	Caravan Park has a dedicated connection	200 kVA	1	unknown solar, unknown peak demand
Surf Club	Single connection to Surf life saving club	25 kVA	1	6kW solar, unknown peak demand
VENUS BAY 7	Pub, Motel, Hall, Hardware, Churches	200 kVA	36, 25 homes	38kW solar, restricted exports, 93 kVA peak demand
CANTERBURY ANTHONY	Venus Bay Community Centre, NBN & Telstra exchange	100 kVA	66, 63 homes	71kW solar, restricted exports, 70 kVA peak demand
LEE CORAL 93	Mens shed & CFA	100 kVA	43, 41 homes	45kW solar, restricted exports, 52 kVA peak demand

The top four feeders in this list have been chosen for deeper assessment in this report. They represent the most critical services that Venus Bay and Tarwin Lower rely on. They are the largest transformers and supply to 236 customers. They provide geographic diversity because they are located across the three largest residential centres. They also offer diversity so that we can learn as much as possible. Both Tarwin Lower sites have a reduced response to the summer peak caused by large increases in visitors.

1. The Venus Bay shops are on a mixed residential/commercial feeder in Estate 1
2. The community services are concentrated on the Tarwin Lower feeder that includes the Recreation Reserve. This site may also be a gathering point in some circumstances, with higher ground and the ability for helicopters to land on the oval
3. The Tarwin shops provide more extensive services and also power up the phone tower, the petrol station and the main CFA. This feeder is almost purely commercial.
4. Testing a community battery for one residential feeder is also recommended because this model would be replicable and energy consumption is expected to follow similar patterns throughout the community. The advantage of Cantor Fishermans is that it includes the only community

[5] Peak demand in this data set is measured before including losses and unmetered loads which contribute a further 5-10%

infrastructure in Estate 2 and a possible gathering point. The electricity consumption of the fishing club is very modest so this remains a good example of a residential feeder.

Recommendations:

A strategic approach to these first four trials is recommended. The 'learning' costs for community batteries are currently very high for the size and scale of investments ($200,000 to $1m). Any trial can showcase:

- a consistent approach across multiple projects to minimise duplication costs in design, community engagement and project management.

- a learning approach so that subsequent projects improve without the need to start from scratch

- the differences in the four battery designs that result from the different load and customer profiles

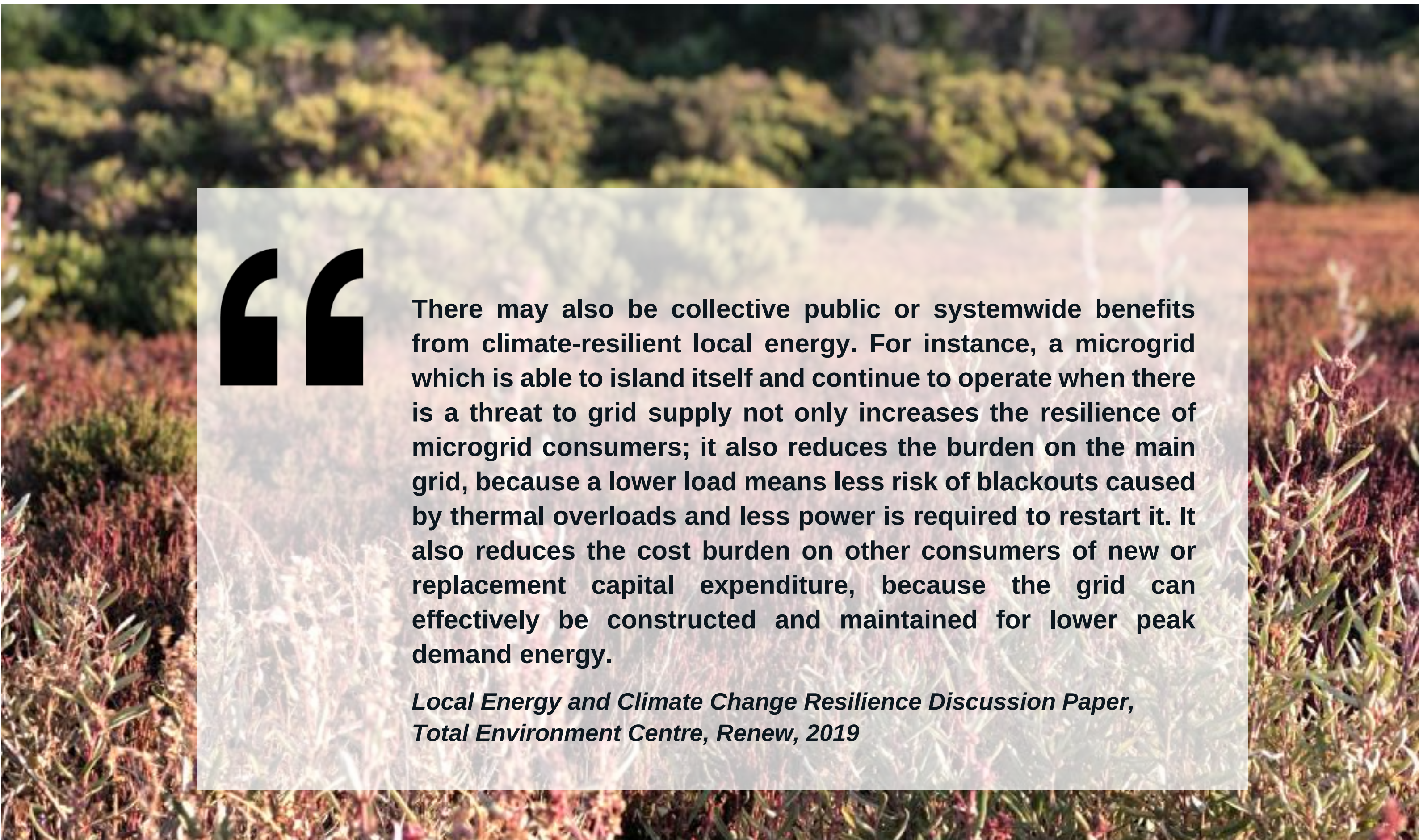
- a possible fifth point of comparison on a feeder where high uptake of household batteries can create a comparison with a neighbourhood battery

- the benefits of starting from community values when designing and sizing batteries.

- the cost savings across the community when a holistic approach to electricity use across renewable energy, flexible load and battery storage is used.

- the cost savings if the ability to focus on essential energy needs is created within a battery project.

Any review of the battery trials should refer back to the original values when asking how well each performed. It should also consider the value of flexible designs that have enabled battery designs and operating regimes to be modified and extended as the community needs change.



> **There may also be collective public or systemwide benefits from climate-resilient local energy. For instance, a microgrid which is able to island itself and continue to operate when there is a threat to grid supply not only increases the resilience of microgrid consumers; it also reduces the burden on the main grid, because a lower load means less risk of blackouts caused by thermal overloads and less power is required to restart it. It also reduces the cost burden on other consumers of new or replacement capital expenditure, because the grid can effectively be constructed and maintained for lower peak demand energy.**
>
> ***Local Energy and Climate Change Resilience Discussion Paper, Total Environment Centre, Renew, 2019***

Capital Costs

There is limited experience in Australia at this stage for suitable capital costs for a community scale battery. The various feasibility reports that have been completed under Victoria's Neighbourhood Battery Initiative quote widely varying costs, with different inclusions and often emphasise a 20-30% uncertainty factor. For example, $1,000/kWh is the low end of the range where cases minimise installation and project design costs, $4,900/kWh has been quoted for the most expensive battery in the Philip Island assessment.

Reliable market information is split across two scales – utility batteries in the 10MW-100MW scale and household batteries in the 3kW to 20kW range. At the scale and low voltage application that this study could consider - 50kW to 500kW - two markets where applicable insight and learning is being developed are commercial applications and remote microgrids. Four relevant applications of community scale batteries incorporate high "learning" costs when considering how the money in each case was spent and therefore only provide modest indications about the cost of a community-scale battery.

- Yarra Energy Foundation, $800,000 grant. Ongoing support from YEF, over 1 year in project development work. Size: 120kW and almost 3 hrs storage at full load (309kWh)
- Tarneit, approximately $1m. Powercor identified approximately 75% as "learning costs" which could reduce dramatically in future iterations.
- Ausgrid, Beacon Hill. Supported by ARENA. Predicting around $400,000 in future. Size: 150kW and almost 2 hrs storage at full load (267kWh)
- Western Power. PowerBank 3 will use 116kW/464kWh batteries. PowerBank 1 received $3.3m from ARENA and was the first project of this kind in Australia. Public information about current costs is limited. PowerBank 3 will be 9 batteries so Western Power is beginning to develop a repeatable project approach with a fixed business model.

Projected future costs, economies of scale and breakdown of costs were considered to choose an appropriate capital cost for the modelling in this report.

Projected future costs and cost equation

The two main drivers of battery size are capacity usually provided as kW and length of time or volume of energy that defines the battery operation, usually provided as kWh or hours duration.

Capacity (kW) x hours duration = size (kWh).

Some components of a battery system are priced according to capacity, especially the inverter, switchgear and protection equipment. The battery cells are the key to energy production and are priced according to size in kWh.

CSIRO track annual costs of batteries and full battery systems for utility scale applications and in reporting to the Australian Energy Market Operator for its energy system planning. Figure 8 shows the projected cost of large battery systems according to the CSIRO. (BoP means Balance of Plant and referes to the inverter, containerisation and other connection and control systems).

This graph can be interpreted as demonstrating a cost equation of:

Capital Cost = $550 x Capacity(kW) + $300 x duration (kWh)

By 2035 the main cost reduction is expected to come in the Lithium Ion cells that are projected to reduce costs to $100 x duration (kWh) with minimal movement on the costs of Balance of the Plant.

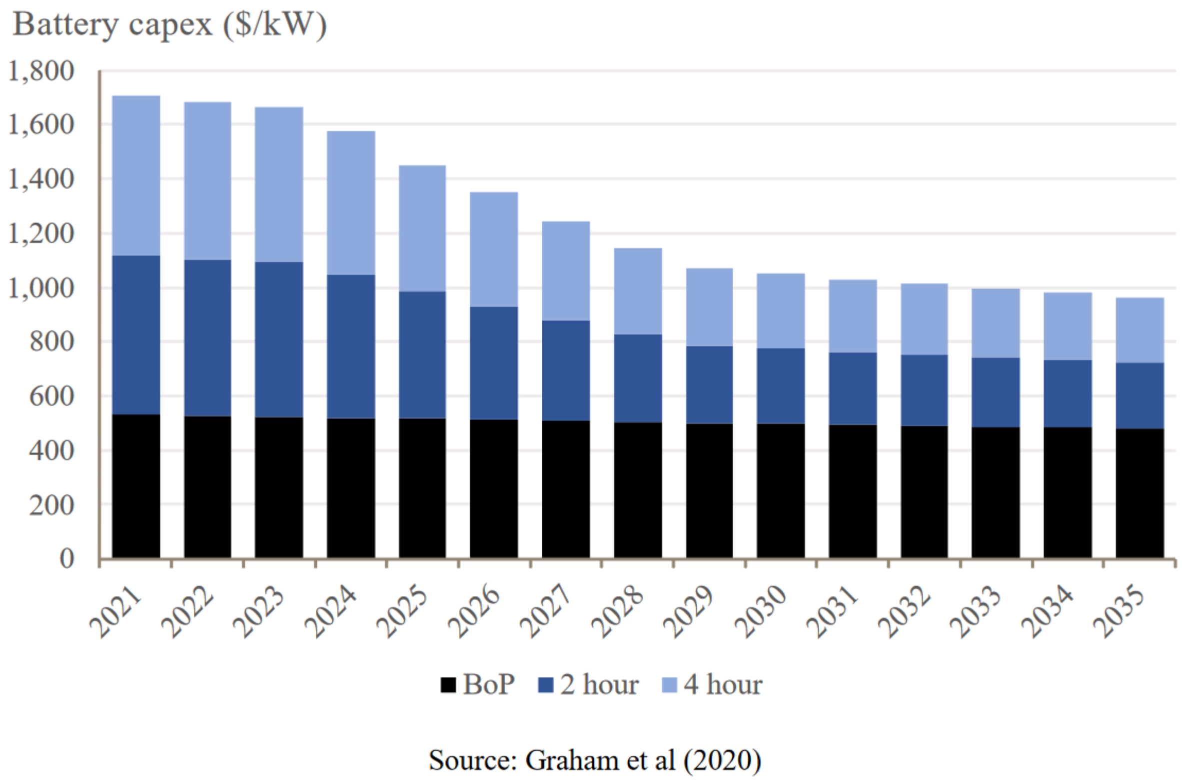


Figure 8 Projected Capital Costs for grid scale batteries (CSIRO)

Enea took a similar approach with its report for Macedon Ranges and concluded a cost equation of:

Capital Cost = $335 x Capacity(kW) + $575 x duration (kWh) + $205,500 for community-scale battery projects.

Our assessment of a range of battery projects around the size of 100kW / 200kWh suggests the capital cost of the core battery system should aim toward $1,000/kWh when installing a 2 hour battery. We have used the following cost equation for testing different battery sizes and durations:

Capital Cost = $810 x Capacity(kW) + $620 x duration (kWh) + $100,000

A final reference point is household scale battery systems. The Solar Choice Battery Index[6] indicates a benchmark price of $1,500/kWh installed. This index includes rebates where available. One of the key benefits at the household scale is the ease of connection because a houshold is already connected to the grid and utilises its existing switchboard. This gives household system cost a head start over community-scale systems. It is also worth noting that the inverters for islanding or stand-alone capability, typically cost an additional $1,000, adding around 10% to the cost of a household system.

Breakdown of costs

The main cost components across different projects can be categorised into three areas with different cost drivers, plus ongoing operating costs.

Fixed project costs

Fixed costs are the most variable and site-specific component of a battery project. If a battery remains on the chosen site for a long time, these costs are unlikely to be repeated, even while other components wear out and need replacement. In an uncertain and innovative environment, these costs make projects uncompetitive and are written off as learning, capacity or long-term infrastructure investments. Nevertheless, they are real and projects that underestimate them will carry higher risks into the

[6] https://www.solarchoice.net.au/residential/battery-storage-price/

implementation phase of a project. The opportunity to carry out a full business case on battery projects will allow Venus Bay Community Centre to reduce these risks by delivering some of the components below in advance of implementation, and by pricing the remainder to a much higher degree of certainty.

Site- specific costs: Ground preparation, electricity connection, possible grid extension, possible land purchase, site security.

Permissions and Approvals: Electrical connection approvals from the electricity network provider (i.e. Ausnet Services) and planning approvals from council. This can also include legal costs and contractual costs relating to land and site owners and battery hosts.

Engineering and Design: Yarra Energy Foundation emphasised the importance of using a modular, factory-built system and opted for PiXii whose original role was systems for telecommunications assets and whose core technology is micro-inverters (i.e., can use cells from a range of manufacturers). When installing a modular system, much engineering and design is incorporated by the manufacturer and only additional integration engineering is required. The Venus Bay and Tarwin Lower Energy Project will need to invest in additional engineering during the business case to identify acceptable trade-offs between battery chemistry and community ambitions and to work with Ausnet Services on the options for islandable operation.

Community engagement and stakeholder management: A large unknown for the four sites chosen in this report is the business model that will work best for each site. The ambition needs to be to develop a business model or models that can work for all three stakeholder types: Householders that may be connected directly to the battery feeder or may be part of the wider community, businesses and community organisations. Engagement will be an important component of both business case development and implementation because some agreements and social licences will need to be in place before the community agrees to proceed and apply for battery funding.

Project Development costs: Invariably conceiving of a project, bringing all the components together, and managing stakeholders and governance involves a continuous organising presence. Project development can be a significant cost to any project, especially when it is the first of its kind, or involves significant customisation.

Other costs: Some projects have allowed larger costs for metering and controls in order to participate in FCAS markets. At least one project has allowed for financial auditing.

A sample budget breakdown of $100,000 for fixed costs is shown in Table 4:

Table 4 Sample budget of fixed costs

Fixed Cost Element	Cost per project
Ground Preparation	$5,000
Connection application and assessment	$15,000
Permissions and approvals - council	$3,000
Project Development	$15,000
Engineering & Design	$25,000
Community Engagement	$22,000
Other Expenses such as metering and controls	$10,000
Auditing	$5,000

It is evident from the sample budget that some expenses will carry significant uncertainty until additional work has been carried out in developing the business case and ascertaining project viability before defining more precisely the additional work that will be carried out during implementation – for example engineering design and community engagement.

It is also clear that “cookie cutter” projects eliminate or streamline many of these costs and even approval processes can become cheaper over time as each relevant institution “learns”.

Capacity and energy related costs

Capacity related costs will include the inverter/s, the switchgear and protection and the container to house the battery system. It will also include control systems, metering and monitoring and connection to the grid. It is evident that these capacity related costs do not scale perfectly with battery capacity and there will be some economies of scale for larger projects. As discussed above, this report uses $810 for every kW of battery capacity to cover the costs of these components.

Energy related costs mainly relate to the battery cells. Lithium-Ion batteries are part of a commodified market serving everything from mobile phones to electric vehicles and cells tend to come built into modular units that can be switched in and out of a battery system. Other battery chemistries will not obey the cost benchmarks that the industry, this report and many other neighbourhood battery feasibility studies have been using, so Lithium Ion becomes the benchmark cost for assessment. This report uses $620 for every kWh to cover the cost of cells, their modular units, the associated cabling and unit-based monitoring and controls, as well as commissioning and testing costs.

Table 5 Core technology cost benchmarks for a range of battery system sizes

Battery Duration / Energy Size Battery Capacity	1 hr	2 hr	4 hr	8 hr
50kW	$72,000	$103,000	$165,000	$289,000
80kW	$115,000	$165,000	$264,000	$463,000
100kW	$144,000	$206,000	$330,000	$579,000
120kW	$172,000	$247,000	$396,000	$694,000
150kW	$215,000	$309,000	$495,000	$868,000
200kW	$287,000	$411,000	$660,000	$1,157,000
300kW	$430,000	$617,000	$990,000	$1,736,000

Operating costs

Operating costs can be minimal if the battery is set with a simple operating cycle and can be monitored remotely and fixed easily. Some projects, however, build in significant operating costs because there are licence fees for control software, high speed electricity market access, data management and billing. A community battery indicates a level of community interaction and any benefit sharing may involve levels of communication and management that more technical projects consider irrelevant.

Operation and maintenance costs from $1,000 per year up to $14,000 per year can be found in other studies. Our assessment allows for $3,000 per year in operating costs.

Economies of scale

KPMG, in its report for Ausgrid, provided a range from $3,500/kWh for smaller, short-duration batteries (eg 100kW/100kWh) down to $1,000/kWh for a larger 550kWh battery. The report was prepared in 2020, however it is a reminder to ensure that battery costs for smaller battery systems are not overly optimistic.

Battery performance and lifetime

Battery performance is another area of large uncertainty and needs to be defined by each manufacturer. A typical warranty of 10 years will include definitions of operating temperature, maximum and minimum charge and discharge levels, maximum charge and discharge rates because all of these operating parameters can speed the degradation of the battery cells. Battery warranties have been progressively moving to energy throughput as a defining measure of performance, which allows us to understand the kWh that will be produced by a battery over its full lifetime before the manufacturer declares it at end of life. Some manufacturers define 60% of original capacity as end of life and others define it as 80%. Both expect cells to degrade more rapidly after end-of life is reached.

A typical warranty might provide 10 years or a defined energy throughput, depending on which occurs first. For example Tesla household battery warranties equate to a full daily battery cycle every day for seven years, which is just over 2,500 full cycles. Some reports quote 3,500 full cycles however the warranty arrangements for claims like this or greater (6,000-10,000 cycles) do not appear to relate to full cycles. There is therefore a 30% uncertainty, at least, about the quantum of value that can be drawn from a battery system before its cells need to be replaced, noting that cells might be 25% - 50% the original capital cost.

The performance of the battery can have significant implications in the modelling results.

Lithium Ion cells are the most energy efficient chemistry with typical losses of only 10% of the energy used every cycle. Alternative chemistries will need additional modelling before final sizing of the system.

Recommendations:

The business case and financial models for a successful battery cannot rely on general research for the cost and performance basis of the battery. Real quotes and the details of performance warranties need to be identified in order to fully understand costs and risks.

Income streams

Levelised cost of energy from battery

The levelised cost is useful for identifying the circumstances where the battery investment can be profitable.

The uncertainties that surround capital cost, lifetime and performance make this difficult to calculate. Normal levelised cost calculations also introduce discount rates which become meaningless in an innovative environment where short term decisions will drive investment and a series of new parameters will confront the community as the energy market and technology changes disrupt the decision-making basis.

Nevertheless, it is worth noting that utility scale batteries are estimated to be operating at 20 to 25c/kWh for lifetime energy performance. The more expensive, community scale batteries discussed in this report will cost around 35-40c/kWh if some fixed costs are not included in the analysis. This is around the price of electricity which means batteries struggle to make sense when confronted with ordinary pricing arrangements where the marginal costs for peaks and gluts are hidden from consumers. Batteries must also pay for the energy used to charge the battery so the difference in pricing between low-cost surplus and high-priced peak energy becomes the key to profitability.

Another insight from the use of levelised costs is that the value of the battery cells is around half the levelised cost – i.e., 17 – 20c/kWh. This means that running the battery hard for any revenue is a poor strategy, yet many battery models apply this logic. Instead, a battery should only cycle if the revenue is worth more than 17 c/kWh because the alternative is to degrade the battery cells for a lower price than it will cost to replace them. Real replacement costs should be used to understand the cost of the decision to cycle a battery. These are known as short run marginal costs. In diesel generators, for example, the short run marginal cost is the cost of the fuel and some additional maintenance.

Income streams

Energy bills pay for network costs, generation costs, retailing and a few other charges associated with renewable energy and environmental services. Payments are made for surplus solar energy and the Victorian government sets a mandatory feed-in tariff each year. It is currently 5.2c/kWh.

A battery that shares a customer meter is known as a "behind-the-meter" battery. The value flows will be measured in large part in how much it can reduce the customer's bills. Nevertheless a customer can choose to access some wholesale market charges directly, depending on the pricing arrangements with its electricity retailer. Virtual Power Plant arrangements have brought payments, based on the retailer access to wholesale and ancillary markets[7], to ordinary battery owners.

Front of the meter batteries are treated like customers and the network businesses are still experimenting to determine appropriate charging arrangements. They are assets that can support a retailer and its hedging position on the electricity wholesale market. They can also help a retailer with too much surplus solar. Retail arrangement for any battery need to be carefully negotiated. While community values and needs come first, retailer risks and benefits will also need to be aligned in the operating regime of the battery.

Electric Vehicles could be served directly by neighbourhood batteries, alleviating the pressure vehicle charging might ultimately place on the electricity network. These are not trivial loads. Electric vehicles will not need charging every day but when they do, or if fast charging is valued by the owner, charging stations

[7] Frequency Control and Ancillary Services are known as FCAS and have been modelled as a significant revenue base in many studies.

linked to neighbourhood batteries will have value. Ideally, electric vehicles should charge at times of surplus solar and costs should be allocated accordingly when this is not possible.

Results

The four Low Voltage batteries modelled in this study are connected to electrical feeders with the following transformer capacities and peak loads.

Table 6 Transformer capacity and peak load

Feeder Name	Description	Transformer Capacity	Peak Load[8]
Jupiter Centre	Venus Bay shops	315kVA	185 kVA
Tarwin Lower 94	Recreation Reserve and community buildings	315kVA	106 kVA
Cantor Fishermans	Estate 2 residential plus fishing club	315kVA	101 kVA
Venus Bay 2	CFA, main shops & petrol	500kVA	112 kVA

The peak load starts to provide insights into the maximum capacity of each battery that might be valuable. Peak load may grow:

- with additional activity in the community, and one challenge will be to support newcomers and visitors to understand the community ambitions and to invest in energy efficiency;
- with growing electrification. The community challenge is to divert new electrical loads into times of surplus and cheap energy;

Peak load is unlikely to reduce. It occurs precisely at times when low solar, high heating or cooling needs, and high activity such as evening dinner time coincide.

The other sizing consideration for battery capacity is the ability to charge the battery from surplus solar and make space on the feeder for more solar investment. This may become a consideration in future and any battery should be sized after considering future solar uptake and flexible load ambitions.

Table 7 Current solar capacity and peak export levels

Feeder Name	Current Solar kW	Peak Export[9]
Jupiter Centre	61kW solar, restricted exports	18 kW
Tarwin Lower 94	109kW solar, restricted exports	52 kW
Cantor Fishermans	38kW solar	24 kW
Venus Bay 2	81kW solar	30 kW

Energy and duration sizing of each battery relies on finding the right balance between a cost-effective investment and the value of reliability which would see a battery sized to supply power during outages of over 4 hours. If a battery can provide all essential overnight energy needs, it may be able to power a feeder for multiple days when solar energy to recharge the battery is available each daytime. Tx compares three potential sizing parameters

Table 8 Possible sizing parameters for battery energy and duration

Feeder Name	Maximum energy use in premium times (6pm – 9pm)	Maximum overnight and essential @ 25% of full load	Average Overnight and essential @25% of full load
Jupiter Centre	484 kWh	637 kWh	302 kWh
Tarwin Lower 94	295 kWh	362 kWh	166 kWh
Cantor Fishermans	196 kWh	309 kWh	103 kWh
Venus Bay 2	260 kWh	444 kWh	314 kWh

[8] This is an Ausnet estimated peak demand which includes transformer and line losses and unmetered loads.
[9] kVA from Ausnet data has been converted to kW by assuming a power factor of 0.95

The load profile across the year for each feeder is shown in Figure 9. Both feeders in Venus Bay respond more strongly to the visitor peak in summer (and Easter) and to the cold winter weather. The shops in Tarwin Lower also experience the summer peak, although the spike on New Year's Eve is not evident. The community facilities on Tarwin Lower 94 have a much steadier profile throughout the year. The fluctuations highlight that a battery sized for a peak will not be deployed consistently throughout the year and this will undermine its revenue.

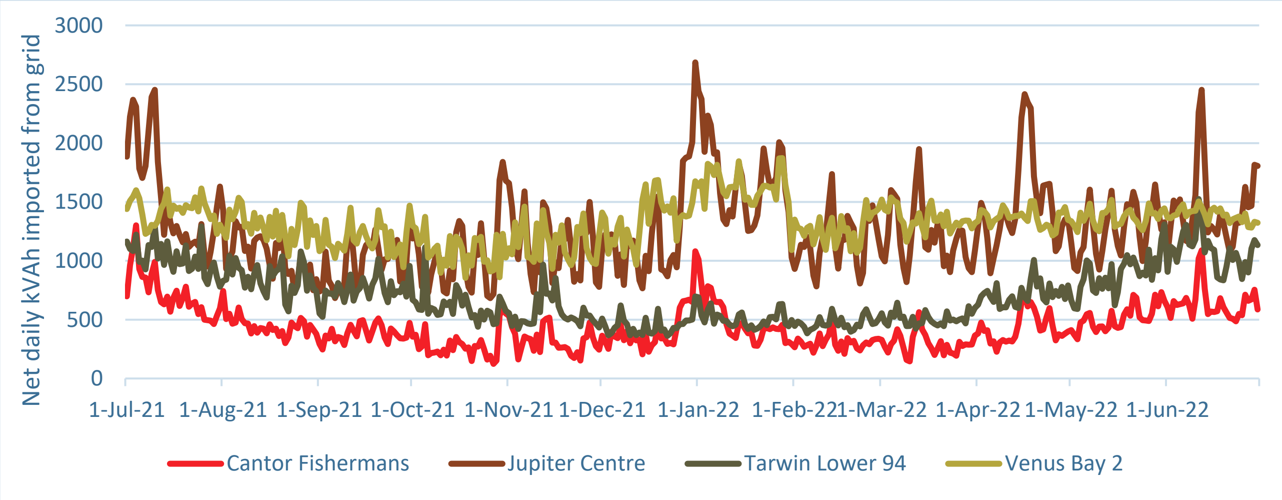


Figure 9 Load profiles across four selected feeders

The following battery parameters are used during the modelling of all four feeders:

Battery System	Parameter
Round trip efficiency	90%
Economic Life – Battery cells	3000 full cycles or 10 years
Economic Life – Balance of Plant	20 years
Operation & Maintenance costs	$3,000
FCAS market assumptions	Not used - $50/kW/year would be a modest assumption
Value of surplus solar	Not used – figures based on difference of 40c/kWh
Value of electricity purchased at peak times	

Jupiter Centre

Jupiter Centre is the name of the feeder that serves the shops in Venus Bay, including the general store, the chemist and a number of important food outlets. As well as 20 shops, it serves 75 homes in one of the oldest parts of Venus Bay. It has a 315kVA transformer and with a peak load of 185kVA, there is plenty of capacity for load growth. The 61kW of solar (installed in a number of large systems on the shops and only on around 8 households) is already restricted to 56kW of exports, even though the maximum export reached is only 18kW. This limit warrants further investigation and discussion with Ausnet. The load profile shows that peak demand is significantly higher across a small number of days. Sizing a battery to serve these high loads only occasionally will not be cost-effective. The chemist, and more recently, the general store, have invested in backup generation.

Proposed battery system

A neighbourhood battery would be located at the shops, near the transformer. During outages it would maintain power. The exact sites that will remain powered will depend on negotiations with Ausnet:

- Ideally, the whole feeder would remain powered and would reduce its needs to essential loads.
- Maintaining power to shops on both sides of the road would be a second choice. This would require an additional switchboard to create a small embedded network.
- The general store could be the site to remain powered with a behind-the-meter arrangement to optimise battery value in both everyday and outage circumstances. It is the largest energy consumer and provides the most important community service.

The potential location of the battery near the shops is shown below:

Figure 10 Venus Bay Shops and transformer

Load profiles and recommendations for increased solar and flexible load

The peak day occurs in summer, coincident with large visitor numbers, dinner time, and hot weather with airconditioning needs expected to be causing the peak. On summer and winter peak load days the solar output is lower than the underlying load. On the day of peak solar export the peak load is less than 60kVA.

The profiles for summer, winter and peak solar exports are shown below.

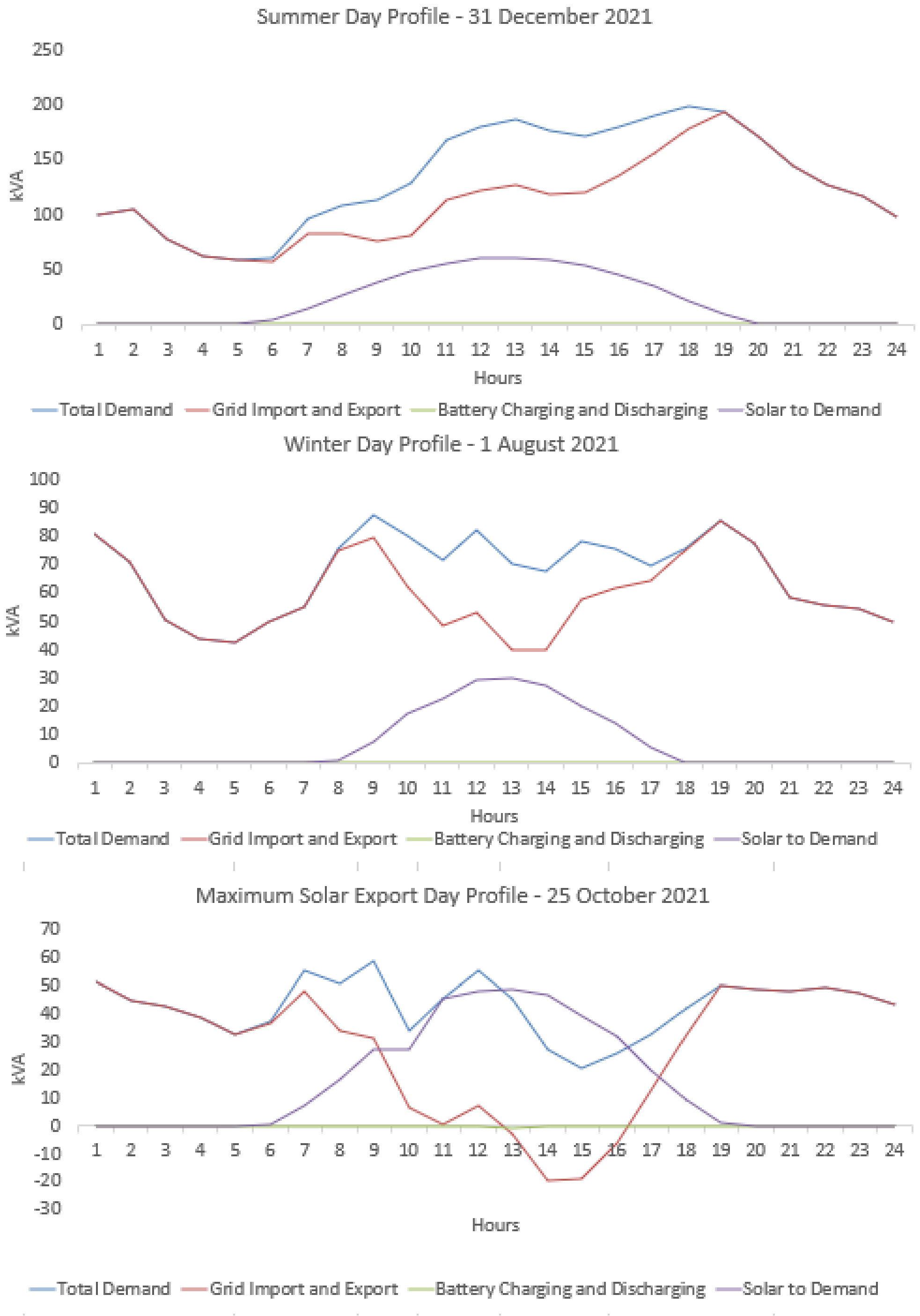


Figure 11 Jupiter Centre load profiles

Solar first

Since the feeder has limited export and restricted solar capacity, the greatest value of the battery would be in allowing increased solar uptake. Tripling solar across the feeder to 180kW would take exports to 30% of solar capacity. At an investment of $120,000, this would save households approximately $18,000 per year.

If the battery operates without surplus solar it will rely on electricity from the wholesale energy market[10] to charge. With 180kW levels of surplus solar increase from near zero to 30% of all solar produced. A 300kWh battery can halve this surplus.

Flexible load next

The potential for moving hot water loads from night to the surplus solar period in the middle of the day is approximately equivalent to a 150kWh battery and will be significantly cheaper. Where saving money for householders is the goal, this should be the next priority for the Venus Bay and Tarwin Lower community.

Sized for reliability

The Jupiter Centre feeder has been assessed with the following input parameters. In combination with increased solar and flexible load a battery of this size should be able to maintain power during extended outages in most seasons and load conditions. During an extended winter outage, it may only be able to maintain power with generator support and only to the most important loads at the chemist and general store where stock losses can be very expensive.

Table 9 Jupiter Centre Assumptions and results

Jupiter Centre Battery System	Input Parameters
Additional solar uptake	120kW
Flexible load	140 - 165 kWh/day
Battery Size - Capacity	100 kW
Battery Size - Energy	300 kWh
Capital Cost	$367,000
Key Assumptions to be negotiated with Ausnet	Location of battery which may change when the cause of export limits is understood. Ability to disconnect within Ausnet system or build an embedded network for the shops

Jupiter Centre Battery System	Results
Energy shifted from solar to high value time	40,000kWh / year
Duty cycle of battery for solar only	37% (100% is a full daily cycle)
Revenue/savings at 40c/kWh price difference	$16,000 per year
Nights of year where battery size is insufficient for supplying essential load	33 days per year will require additional measures to last for the full period of an extended outage
Value from 20 hrs outage per year ($22/kWh for 20hrs)	Average load is 63kVA Essential load is 16kVA $6,900 per year

Key Result: Battery operates at 37% duty cycle when charging only from solar energy. It shifts 40 MWh per year from low value to high value times. If 40c/kWh uplift in value can be achieved on average, this will generate $16,000 per year in revenue or savings.

[10] Solar exports receive a feed-in tariff of 5.2c/kWh at the moment and the wholesale market price in the middle of the day is valued at 2.5c/kWh. These low prices are only available for part of the year when there is plenty of sunshine. https://www.esc.vic.gov.au/electricity-and-gas/prices-tariffs-and-benchmarks/minimum-feed-tariff/minimum-feed-tariff-review-2022-23 .

Recreation Reserve, Clubs and School

Tarwin Lower 94 is the name of the feeder that serves the recreation reserve, its clubs, a primary school and a health centre. It also has 47 households connected to this feeder. It has a 315kVA transformer and with a peak load of 106 kVA, there is around 200 KVA capacity for load growth. The 109 kW of solar (installed across only 12 large systems, primarily in the recreation reserve, clubs, and school) is already restricted to 103 kW of exports. The export limits and conflicting numbers of customers reliant on this feeder, warrants further investigation and discussion with Ausnet. The load profile shows that peak demand occurs during the winter season due to the household consumers and heating at the school and the clubs in cold weather.

Proposed battery system

A neighbourhood battery would be located at the recreation reserve because this is the most important location in the whole community to remain powered during emergencies. The exact sites that will remain powered will depend on negotiations with Ausnet:

- Ideally, the whole feeder would remain powered. The school may become important during emergencies but any move to creating a safer place will require negotiations with Council and emergency services.
- Maintaining power to all the clubs in the recreation reserve would require an additional switchboard to create a small embedded network. This was probably the original design of electrical wiring but the site is now served by 3 meters – Bowls club, Football oval lights and showers, Footy clubhouse.

Load profiles and recommendations for increased solar and flexible load

The peak day occurs in summer but the Tarwin Lower 94 feeder has a muted response to the large visitor numbers in summer. Instead peak loads are influenced by heating and cooling on the coldest and hottest days. The school and the clubs are both significant loads with different activity levels driving the peak at each site. The solar exports are occurring in both summer and winter and the day of peak solar export is 22 December when the school is closed. 18% of the solar energy produced on the feeder is exported to Tarwin Lower more widely. The households in Tarwin Lower are more likely to be permanent residents so energy consumption is more consistent on a daily basis. This consistency supports a community battery because it can cycle with a similar charge and discharge profile every day.

The profiles for summer, winter and peak solar exports are shown below.

Solar first

Since the feeder has restricted solar capacity, there remains value if the battery can allow increased solar uptake. Doubling solar to 200kW would take exports to 30% of solar capacity. At an investment of $90,000, and anticipating self-consumption of only 50%, this would still save households approximately $17,000 per year.

When the battery operates without surplus solar it will rely on electricity from the wholesale energy market to charge. With 200kW of installed solar, levels of surplus solar increase from 18% to 37% of all solar produced. A 150kWh battery can reduce this surplus by 30%.

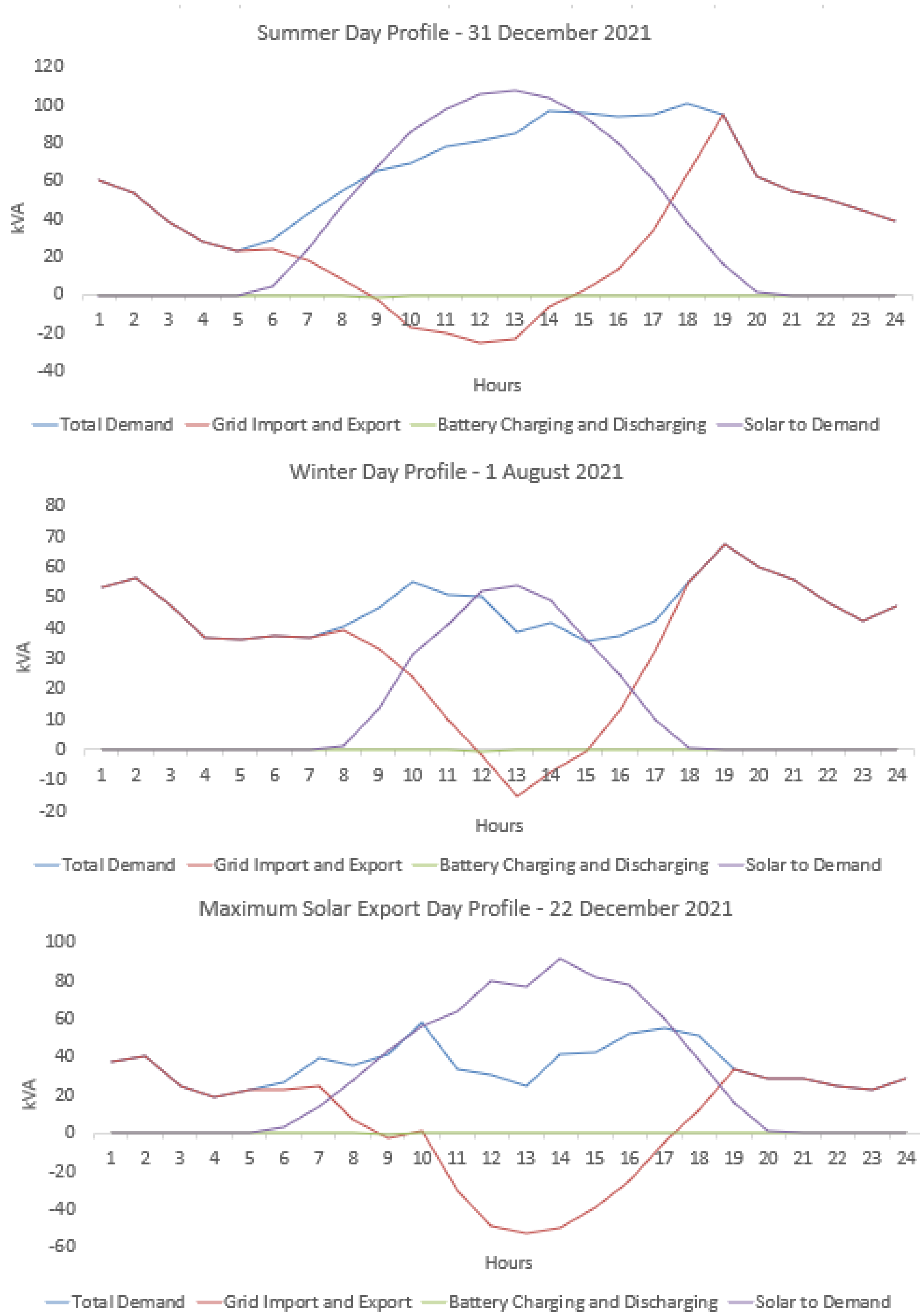


Figure 12 Tarwin Lower 94 load profiles

Flexible load next

The potential for moving hot water loads from night to the surplus solar period in the middle of the day is approximately equivalent to a 130kWh battery and will be significantly cheaper. Where saving money for householders is the goal, this should be the next priority for the Venus Bay and Tarwin Lower community.

Sized for reliability

The Tarwin Lower 94 feeder has been assessed with the following input parameters. In combination with increased solar and flexible load a battery of this size should be able to maintain power during extended outages in most seasons and load conditions. It is worth noting that the load will exceed “essential only” loads if significant numbers of residents and visitors from Venus Bay and Tarwin Lower descend on the

Recreation Reserve during an emergency. Opportunities to build a flexible arrangement for emergency energy needs, such as the ability to plug in a 50kW mobile generator, should also be investigated.

Table 10 Tarwin Lower 94 assumptions and results

Recreation Reserve Battery System	Input Parameters
Additional solar uptake	80kW
Flexible load	100 - 130 kWh/day
Battery Size - Capacity	60 kW
Battery Size - Energy	150 kWh
Capital Cost	$242,000
Key Assumptions to be negotiated with Ausnet	Location of battery which may change when the cause of export limits is understood. Ability to disconnect within Ausnet system or build an embedded network for the recreation reserve

Recreation Reserve Battery System	Results
Energy shifted from solar to high value time	30,000kWh / year
Duty cycle of battery for solar only	58% (100% is a full daily cycle)
Revenue/savings at 40c/kWh price difference	$13,000 per year
Nights of year where battery size is insufficient for supplying essential load	80 days per year will require additional measures to last for the full period of an extended outage
Value from 20 hrs outage per year ($22/kWh for 20hrs)	Average load is 45kVA Essential load is 11kVA $4,900 per year*

*when the school has no power, parents are requested to come and pick up children. This represents an economic disruption for the community and may warrant a higher value to be chosen for reducing outages.

Key Result: Battery operates at 58% duty cycle when charging only from solar energy. It shifts 30 MWh per year from low value to high value times. If 40c/kWh uplift in value can be achieved on average, this will generate $13,000 per year in revenue or savings.

Fishing Club – Providing Power in Estate 2

Cantor Fishermans is the name of the feeder that serves the fishing club and 67 household consumers. It is estimated that half of these households are part-time residents and these houses will often fill up only at peak holiday times. A modest pattern of household usage on weekends throughout the year is also evident in the daily energy consumption data. Cantor Fishermans has a 315kVA transformer with a peak load of 101 kVA and around 200 KVA capacity for load growth. 38 kW of solar is already installed across an estimated 15 households. The load profile shows both summer and winter peaks. It is expected that the summer peak is dominated by the influx of visitors and cooling demands, while stronger winter loads are caused by fewer households but larger energy requirements in winter, especially for heating.

Proposed battery system

A neighbourhood battery would be located at the fishing club because this has been identified as the obvious place for the community to go when Estate 2 is cut off from other parts of Venus Bay. It has a car park for the jetty, public toilets, barbeques and a modest fishing clubhouse with a small kitchen the space of one large room. The whole Estate is a bushfire risk area and a battery in any location would create an additional bushfire risk so the technology for this battery must be chosen carefully. The exact sites that will remain powered will depend on negotiations with Ausnet:

- Ideally, the whole feeder would remain powered. Ausnet may indicate that the battery should move within proximity of the transformer on Cantor Rd if this is to be the case.
- There is little commercial value in placing the battery behind the meter at the fishing club because it is such a small load but there would be community value if the clubhouse could provide energy for the residents and visitors of Estate 2 in case of outages.

Potential location of the battery is shown below.

Figure 13 Fishing club, playground, jetty and three phase electricity supply

Load profiles and recommendations for increased solar and flexible load

The peak day occurs in summer with a peak for both overnight hot water and evening dinner and cooling. The overnight hot water peak persists in winter. The solar exports only occur in mid seasons – in winter the load is high due to heating and lower solar production, in summer the load is high due to visitor numbers. The fishing club and public toilets have minimal energy consumption, lower than a typical household.

The profiles for summer, winter and peak solar exports are shown below.

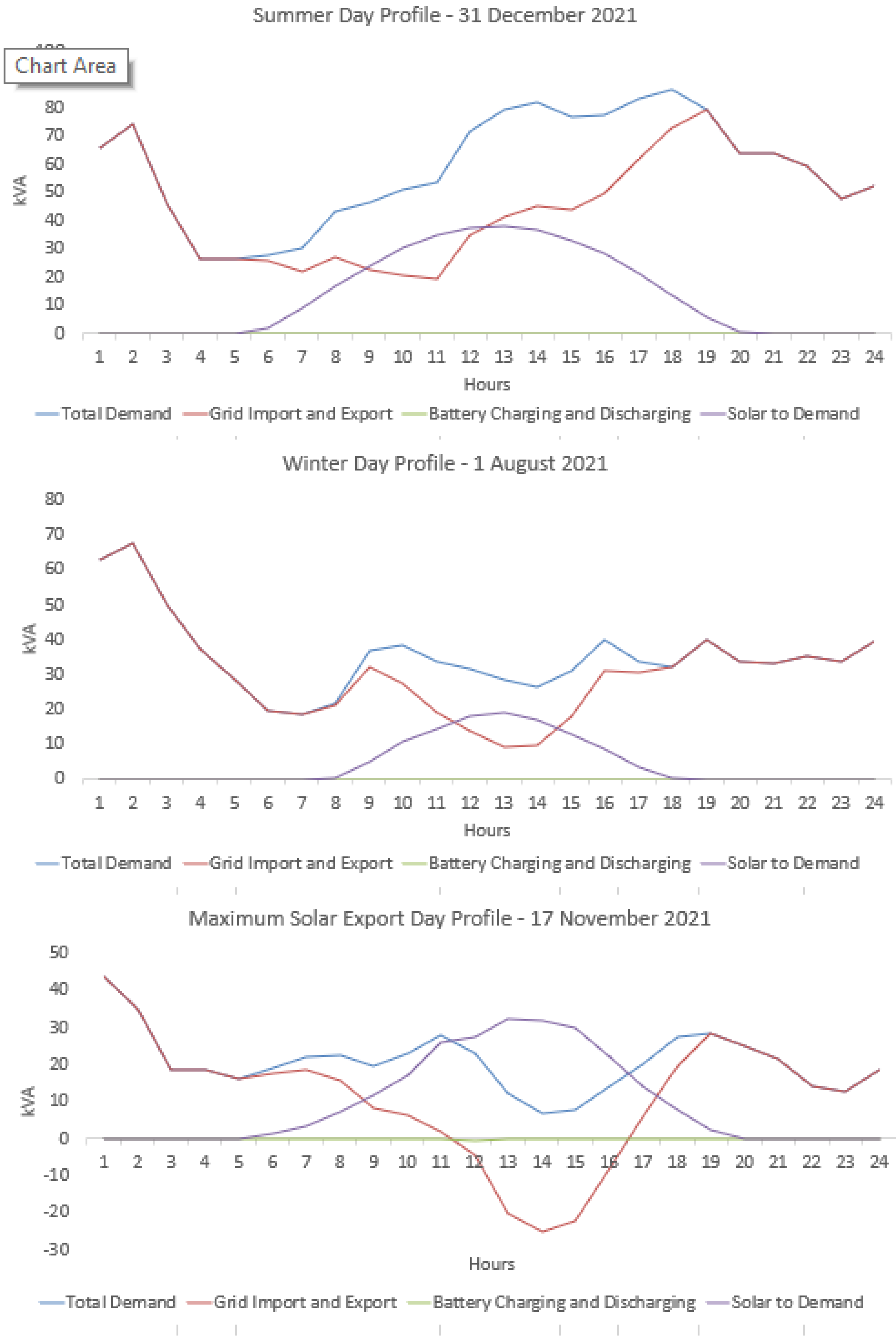


Figure 14 Cantor Fishermans load profiles

Solar first

There are not yet restrictions on solar capacity, and the 40kW of solar that are currently installed amount to only 0.5kW per household. A 315kVA transformer should be able to host over 150kW of solar but this sort of figure varies for each feeder and will need negotiation with Ausnet Services. This would take households to around 2kW per household of solar energy. New approaches such as dynamic hosting capacity, where exports are only limited for a few days of the year would be worthwhile investigating for any residential feeder. Cantor Fishermans is the proposed residential trial so it is worth exploring all activities that build energy self-sufficiency and resilience so the community can make informed decisions about initiatives to roll out across the remaining 32 residential feeders. 15% of existing solar is already surplus because unlike the other feeders in this study, Cantor Fishermans lacks daytime community or commercial loads to use solar energy. Nevertheless adding 110kW, at an investment of $110,000, and anticipating self-consumption of only 35% because many houses are unoccupied for half the year, would still save households approximately $14,000 per year.

When the battery operates without surplus solar it will rely on electricity from the wholesale energy market to charge. With 150kW of installed solar, levels of surplus solar increase from 15% to 63% of all solar produced. A battery can reduce this surplus – 100kWh makes a dent and only takes surplus down to 56%. Doubling the energy the battery can absorb to 200kWh provides only a marginal improvement, bringing surplus to 55%.

Flexible load next

Turning the existing hot water peak into flexible load, and converting LPG hot water to electric is a far more effective way to use surplus solar energy, especially because the hot water load is linked to the number of visitor so it is expected to be much higher in summer when the sunshine is available. The potential for moving hot water loads from night to the surplus solar period in the middle of the day is currently equivalent to a 100kWh battery and will be significantly cheaper. The hot water load could be doubled with LPG conversions. Where saving money for householders is the goal, a strategy for introducing flexible load should be the next priority for the Venus Bay and Tarwin Lower community.

Sized for reliability

The Cantor Fishermans feeder has been assessed with the following input parameters. In combination with increased solar and flexible load a battery of this size should be able to maintain power during extended outages in most seasons and load conditions. It is worth noting that the load will exceed "essential only" loads during an emergency and on a residential feeder the uptake of electric vehicles also needs to be a prime consideration when planning for the future. Opportunities to build a flexible arrangement for emergency energy needs, such as the ability to plug in a small mobile generator, should also be investigated.

Table 11 Cantor Fishermans assumptions and results

Recreation Reserve Battery System	Input Parameters
Additional solar uptake	110kW
Flexible load	60 - 100 kWh/day but 200kWh in future
Battery Size - Capacity	50 kW
Battery Size - Energy	100 kWh
Capital Cost	$203,000
Key Assumptions to be negotiated with Ausnet	Location of battery which may change because the fishing club is at the end of the line which has not been sized. Network benefits might be more valuable than the preferred community location.

Recreation Reserve Battery System	Results
Energy shifted from solar to high value time	22,000kWh / year
Duty cycle of battery for solar only	61% (100% is a full daily cycle)
Revenue/savings at 40c/kWh price difference	$9,000 per year
Nights of year where battery size is insufficient for supplying essential load	27 days per year will require additional measures to last for the full period of an extended outage

Value from 20 hrs outage per year ($22/kWh for 20hrs)	Average load is 25kVA Essential load is 6kVA $2,700 per year

Key Result: Battery operates on average at 61% duty when charging only from solar energy. It shifts 22 MWh per year from low value to high value times. If 40c/kWh uplift in value can be achieved on average, this will generate $9,000 per year in revenue or savings.

Petrol Station, Fire Station and Shops

The Venus Bay 2 is the feeder name of the largest transformer in the community (500 KVA) mostly supplying shops, community buildings, and only two household consumers. It appears to be new because the IGA was recently moved into a purpose-built, new building. The peak demand of this feeder is 112 KVA, hence, there should be plenty of capacity for load growth and more solar. The 81 KW solar already installed is mainly due to the IGA which is the largest load and also operates its own generator for emergencies. The load profile shows fairly small variations throughout the seasons with peak in the Summer (Jan.-Feb.). This feeder has been chosen because the main fire station and the petrol station are serviced from it. These are considered essential infrastructure for a resilient community. Even though the reliance on petrol will start to decline, many participants in community workshops identified their cars as sources of energy during outages and would use car battery power to recharge a mobile phone. Leaving the community during outages might always lead to some residents needing to fill up the car before they can leave. This feeder also serves a mobile phone tower and telephone exchange. The investigations associated with telecommunications assets are still underway but Workshop 1 identified that the battery power in the towers and exchanges is often not sufficient for extended outages. None of them are equipped with solar energy to manage multi-day outages.

Proposed battery system

The proposed location for a neighbourhood battery would be the fire station which is immediately adjacent to the transformer. During outages it would maintain power. The exact sites that will remain powered will depend on negotiations with Ausnet:

- Ideally, the whole feeder would remain powered and would reduce its needs. More work would be required to identify the essential loads in this commercial setting.
- Maintaining power to the petrol station, the fire station and the telephone exchange would be the priority but may require three battery systems and solar arrangements if Ausnet won't allow use of the shared network. It is worth noting that solar and battery systems in the vicinity of petrol need additional protection to ensure electrical sparks and energy surges don't create a hazard.

The potential location of the battery near the fire station and transformer are shown below:

Figure 15 Venus Bay 2 potential location

Load profiles and recommendations for increased solar and flexible load

The peak day occurs in summer, due to the additional refrigeration, cooling and shopping by visitors in hot weather. The steadiness of the load suggest a battery will be able to cycle regularly and the bias toward daytime activity and load mean that solar energy is already well utilised, in fact the day with solar exports appears to be Christmas day when shops are likely to be closed. The profile indicates that a load has tripped which might be the main reason for exports on that day.

The profiles for summer, winter and peak solar exports are shown below.

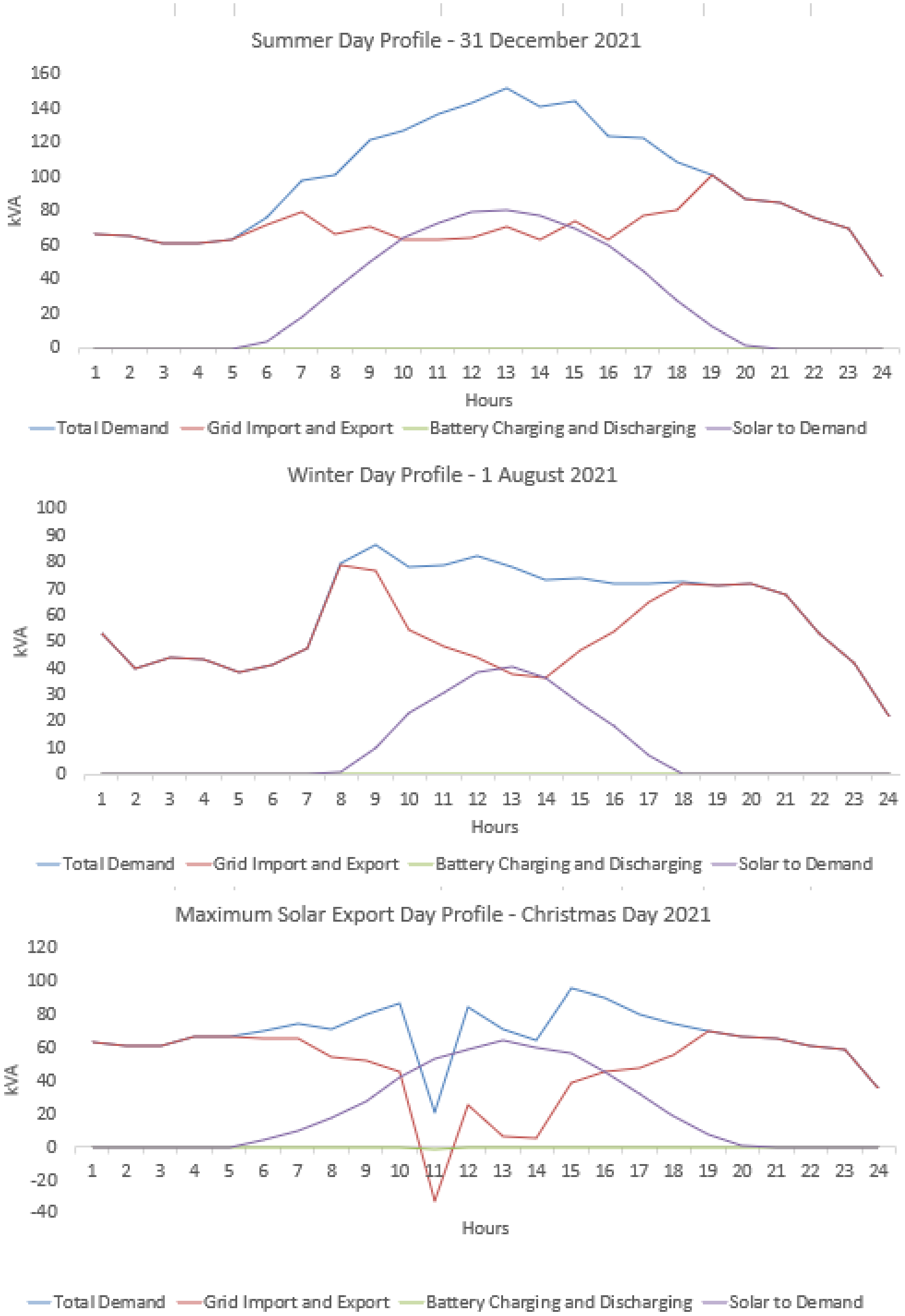


Figure 16 Venus Bay 2 load profiles

Solar first

Since the feeder has underused capacity and plenty of load to use the solar energy it is worth increasing solar production first. Without residential loads, however, the challenge will be to identify suitable roofspace. Adding 200kW leads to surplus solar of only 33%. This would need an investment of around $200,000. A secondary challenge is to match the roofspace with the energy consumption. If the host businesses can only self-consume 50% of the solar production, savings will be $37,000 per year but matching solar with load will lead to higher savings.

If the battery operates without surplus solar it will rely on electricity from the wholesale energy market to charge. With 200kW levels of surplus solar increase from near zero to 33% of all solar produced. A 300kWh battery can reduce this surplus to 23% of solar production.

Flexible load next

The potential for making some loads flexible is more complex in a commercial environment. The IGA refrigeration loads will be the most significant thermal loads on the system and thermal loads such as heating, cooling, refrigeration and hot water are all suitable for energy storage. Some benefits can be gained simply by moving temperature settings to use more energy during the day and less at night. This area will require further investigation. On the three other feeders we focused on the load between midnight and 4am and assumed that 75% of it could be flexible as it is largely caused by residential hot water. This is not likely to be the case on the Venus Bay 2 feeder but if 75% of the load in that period could be shifted, it would be worth the same as a 150kWh battery.

Sized for reliability

The Venus Bay 2 feeder has been assessed with the following input parameters. In combination with increased solar a battery of this size should be able to maintain power during extended outages in most seasons and load conditions. During an extended winter outage, it may only be able to maintain power with generator support and only to the most important loads at the chemist and general store where stock losses can be very expensive.

Table 12 Venus Bay 2 assumptions and results

Jupiter Centre Battery System	Input Parameters
Additional solar uptake	200kW
Flexible load	0 to 150 kWh/day
Battery Size - Capacity	100 kW
Battery Size - Energy	300 kWh
Capital Cost	$367,000
Key Assumptions to be negotiated with Ausnet	The level of hosting capacity that would be suitable on this feeder and the ability to island all the loads as one system during outages.

Jupiter Centre Battery System	Results
Energy shifted from solar to high value time	50,000kWh / year
Duty cycle of battery for solar only	45% (100% is a full daily cycle)
Revenue/savings at 40c/kWh price difference	$19,000 per year
Nights of year where battery size is insufficient for supplying essential load	16 days per year will require additional measures to last for the full period of an extended outage
Value from 20 hrs outage per year ($22/kWh for 20hrs)	Average load is 69kVA Essential load is 17kVA $7,600 per year

Key Result: Battery operates at 37% duty cycle when charging only from solar energy. It shifts 40 MWh per year from low value to high value times. If 40c/kWh uplift in value can be achieved on average, this will generate $16,000 per year in revenue or savings.

Alignment with Neighbourhood Battery Initiative outcomes

Driving down power bills

The feasibility of each battery clearly demonstrates that energy costs can be reduced if the right combination of well-sized solar generation and flexible load is deployed alongside each battery. It is recommended that revenue from the front-of-meter batteries is deployed to unlock these longer term sources of value across the community. We estimate that battery revenue of $xxx,000 over the 10 year battery lifetime can be converted to $yyy,000 savings on power bills over zzz households. Energy Efficiency can also unlock battery capacity for higher value purposes, and more importantly is a valuable investment for driving down power bills.

Behind-the meter battery options include batteries co-located with commercial loads and those co-located with the load of community buildings. Both options will need negotiation with the site owner but community benefits will be delivered in different ways. Battery revenue can be used to reduce the bills of the site owner significantly, or an organisation may choose to continue to pay for the service in return for a modest saving, and knowledge that more of the battery revenue is being returned to the community by supporting an ongoing energy bill reduction program.

Supporting understanding of battery benefits

Battery projects introduce communities to the details of energy storage and the edges of feasibility. There is a widespread belief that batteries will solve all our challenges and all we need to do is wait for the price to come down. This narrative is over-simplistic and the energy transition benefits from a more nuanced understanding of energy futures, supported by diverse renewable energy forms, multiple possibilities to dispatch generation or use load flexibly and investments in storage to round off a holistic solution.

Each of the batteries proposed in this study will highlight different ways of realising value from a battery investment:

- Jupiter Centre will support an essential group of shops to thrive, making Venus Bay even more attractive to visitors. It will have the opportunity to explore additional services that could be offered by the shops, especially at critical times during outages and emergencies when lack of telecommunications can make visitors especially vulnerable. The battery capacity will be shared between the shops and 75 households so it will provide direct evidence of the benefits of diverse load profiles from commercial and residential loads to battery economics.
- The Tarwin Lower 94 feeder will find the sweet spot for providing electricity across community buildings during outages. The ambition is a situation where the school, health centre and recreation reserve can all be powered during emergencies and outages, providing the support backbone for 2,000 residents and up to 6,000 visitors. The clubs form a community heart and between them can reach most community members so the initiatives driven through this cluster will be communicated to most community members. The feedback from community members will generate insights into the services that are most highly prized – from charging electric vehicles, having somewhere to charge a phone or a temporary spot to rest in comfort.
- The Fishermans Cantor feeder will explore the direct relationship between a battery and its residential neighbours. The business model will be able to identify direct charging and discharging relationships but also methods for sharing benefits across the wider community. The club house and its neighbours will become the residential showcase for the community and household energy initiatives trialled on this street can be promoted to everyone. This residential initiative has less electricity reliability alternatives than the other three feeders. Stand alone power can only be provided to the fishing club in normal circumstances, but an Ausnet partnership could showcase

islandability for a residential system which has benefits for all Australian communities and this would be our ultimate ambition.

- The choice of the Venus Bay 2 feeder has been swayed by the presence of two key organisations – the Country Fire Association and the petrol station. These have been identified as critical infrastructures and services for community resilience. The battery will provide a discussion point about community resilience, about our increasing reliance on electricity and our interrelationships between telecommunications, digital services and electricity. The feeder already has a large solar system and generator at the IGA. The battery will allow us to understand the management of all electricity assets in financially productive ways that bridge the divide between private and communal ownership.

In each case the battery benefits of increased community safety, increased resilience and energy reliability, increased self-sufficiency and sustainability will be showcased. The business models to deliver equity and community wealth building will also be transparently promoted to the community. In each case the interaction of the battery with the rest of the energy supply system and the ongoing transition that challenges us all will form part of the conversation.

Overcoming barriers to deployment

The main barriers to deployment identified in this report are:

- Uncertainty in costs, designs and technology choices mean that even industry players have yet to identify the best use of neighbourhood batteries and the preferred sizing and operating approaches. The Venus Bay and Tarwin Lower communities are leading the way in identifying the values that could be served by battery storage as the first step *before* project design.
- Value capture and value generation is unevenly spread. Average pricing in markets and in electricity network investments fails to reveal the critical and occasional investment decisions that add to electricity system costs. The payment of value for existing asset investment recovery remains a societal obligation. Many values are simply not captured within the electricity market – decarbonisation, economic well-being of a community, equity, resilience and safety are all values that our energy project seeks to deliver and demonstrate to the Venus Bay and Tarwin Lower community. Finally, value generation often relies on the interaction between the battery and other assets such as solar generation. There is no right answer for the level of value that should be allocated to the battery vs the level that should be allocated to the solar energy.
- Business and ownership models for neighbourhood batteries remain in an innovative stage where each project is obliged to develop the model that works for it with an eye to repeatability. Without the guarantee that business model development will be rewarded with repeat business, these innovations are singularly expensive in the context of a relatively small project budget and revenue base.
- Regulatory barriers are mostly highlighted in the relationship with the network provider – Ausnet Services. (there are also regulatory barriers associated with electricity retailing)
    - Ausnet's tariffs sometimes provide perverse incentives to avoid using surplus solar energy (commercial peak times starts at 9am on Ausnet tariffs) and in its letter of support Ausnet alludes to potential trial tariffs but no information has been provided for modelling.
    - Local energy starts to fulfill one of Ausnet's key obligations – provision of adequate capacity to all its electricity users - and there is no understanding how this obligation might be delivered jointly with distributed and diversely owned local energy assets in future.
    - Local reliability assets need to disconnect electricity users from the main grid to manage an outage and continue to supply electricity. On any low voltage feeder where the priority is to maintain energy for multiple users, Ausnet services own, control and remain responsible for the switching assets. The technology for this disconnection is straightforward and used

across single sites. Ausnet services are likely to need to own and operate it and a community such as Venus Bay and Tarwin Lower needs to convince them to do so.

  - If Ausnet will not capture the value generated by such an investment, the regulator will not allow them to make it.

- The size and scale of neighbourhood batteries is awkward. It makes sense to develop solutions on low voltage feeders because the main constraint is the transformer which might be overloaded, or at maximum hosting capacity or both. A cluster of 100 households is a scale which struggles to warrant a dedicated governance structure and can easily become dysfunctional. From a financial perspective, an income of $10,000 to $20,000 per year is also an amount that struggles to support the organisational infrastructure to operate and manage a system. This project will need to identify a scale of activity and a number of batteries to develop the financial and governance inertia that neighbourhood batteries will ultimately need.

The projects recommended in this report persist in tackling these barriers without compromising project design to the most profitable solutions. The community will balance the ultimate cost and sizing trade-offs and make the final decision on battery operating regime for value delivery. It will augment the battery investment with further generation investments and flexible energy use to maximise value. Importantly, it will seek to work closely with Ausnet services and seek to break down the barriers to locally provided electricity reliability. Knowing that this regulatory hurdle may take longer than the project allows, we have also identified a alternative approach in each case. To overcome the cost-hurdle of additional reliability investments our energy project is working closely with the community to distinguish Essential loads from other uses of electricity which allows us to provide the most important services at 25-30% of the capital cost (when compared with sizing a battery to provide reliability to the whole energy use profile).

Informing regulatory reform

We will work closely with a retailer and Ausnet services to develop our models and designs. In both cases we will try and 'push the boundaries', acknowledging that bridging the gap in understanding between the current regulatory situation and community ambitions is equally important to thoughtful regulatory reform. The key issues we will progress with Ausnet are:

  - Tariffs for batteries and mirror tariffs for responsive electricity users.
  - Suitable arrangements for sharing responsibility for capacity provision – both for serving peak load and for allowable solar exports.
  - Permissions to operate parts of the Ausnet low voltage system as microgrids during rare electricity supply backup situations.
  - Long term regulatory changes if innovations in Venus Bay and Tarwin Lower prove to be suitable for widespread adoption.

We will work with Ausnet services and South Gippsland Shire Council to understand the approvals processes and provide feedback for opportunities to streamline and improve them. Both organisations will be on a learning curve with batteries as a novel technology. From a planning permission perspective, the Shire Council will benefit from our community-led approach which will force us to investigate the safety risks and technology opportunities in greater detail and which will offer a ready-made consultation forum for exploring the social licence associated with battery technologies.

Models for benefiting the Victorian electricity system

The Victorian electricity system is likely to follow South Australia into a more volatile space as the generation base shifts to variable renewable sources, particularly adding significant offshore wind. The decline of the brown coal power stations may also be punctuated by failures rather than a stable closure timeline.

Everyone will electrify to benefit from cheap renewables but may not manage that electrification into the times of surplus solar. At the local level, the DNSPs could be facing a tidal wave of transformer upgrades as every transformer becomes overloaded with new electric loads or surplus solar.

The lower cost solution to these challenges is demand that follows supply, rather than our traditional approach of building all the assets people demand – regardless of whether they are only used occasionally. This supply/demand matching needs to happen at a local level. Neighbourhood batteries are part of this solution but only one part. The transformation of local electricity usage will fundamentally change our social practices around energy use and will only occur well if people are involved in the transformation and they talk to their friends and neighbours.

The community of Venus Bay and Tarwin Lower has an ambition to solve all these challenges with its energy project. It will build the right amount of rooftop solar generation for self-sufficiency, but prop up that local energy with surplus wind energy and a preference for buying renewable energy at the right times, particularly in winter when the solar energy is in deficit. It will develop adequate energy use flexibility to allow for strategic use of surplus solar and wind when they are available. It will develop an understanding of energy storage options beyond batteries, including electric vehicles and hot water systems. The battery projects in this study serve as a “trojan horse” to open the conversation with everyone in our community about the future shape of our energy systems.

The community of Venus Bay and Tarwin Lower wants to lead in this space, and wants to share its models with a wider audience because ultimately that leadership, innovation and sustainability will attract visitors to enjoy our community.

Optimising local energy resources

The battery sites chosen in this study will all benefit from an increase in rooftop solar. A variety of renewable, storage and non-renewable energy options were developed at the Energy Project launch and in Workshop 2[11]. The only local renewable resource that makes immediate commercial sense beyond solar would be wind power. The community has a fraught relationship with wind power because Bald Hills Wind Farm sits on its doorstep, disrupting the visual amenity of the pristine coastal environment. The energy relationship with wind will be explored in the broader Energy Project and fits into the battery projects as one cheap charging option. Ie when surplus wind is driving down prices on the wholesale electricity market, the battery should charge, especially as a balance to winter solar deficit.

There are few household-scale batteries in Venus Bay and Tarwin Lower and the battery revenue could be used to encourage battery uptake on feeders that are not included in the four feeders proposed in this study. The Venus Bay Community Centre invested in a solar system addition, a 26kWh battery and small generator to turn the Centre into a place that supports community resilience. It serves as a showcase for the community and will be deployed in any Neighbourhood Battery project to support discussions about the different ways storage assets can be utilised and reduce the need for backup generation..

[11] The Harvest report from Workshop 2 explores a suite of energy options

Each battery project will develop ‘local energy resources’ in the form of flexible and controllable load because these investments complement neighbourhood battery investments and support cost savings across each local system.

Supporting decarbonisation

Local energy self-sufficiency and energy sustainability are community values that promote a vision of a completely decarbonised future energy system. The sizing of batteries in this study has been careful to assess the renewable energy available and underutilised. The level of future renewable energy uptake that would be enabled by Neighbourhood batteries has also been assessed. This study forms part of a larger Energy Project that will explore the decarbonisation that can be achieved through investments, information and programs targeted at:

1. The 2,000+ Households across the community
2. The 20+ community organisations and the community assets they control
3. The 30+ businesses
4. Small clusters of households and businesses sharing a low voltage feeder, of which these four proposed feeders would be the starting point
5. The whole community, especially if a wind turbine or solar farm could be supported with a larger battery and microgrid capability but modestly sized because the community has already made huge strides with pathways 1 to 4.

The Energy Project is due to deliver its Action Plan by July 2023 and delivering business cases for four Neighbourhood Batteries would provide a natural continuation of the project and support the ongoing development of activities across the other four pathways.

COMMUNITY ENERGY

for Venus Bay

and Tarwin Lower