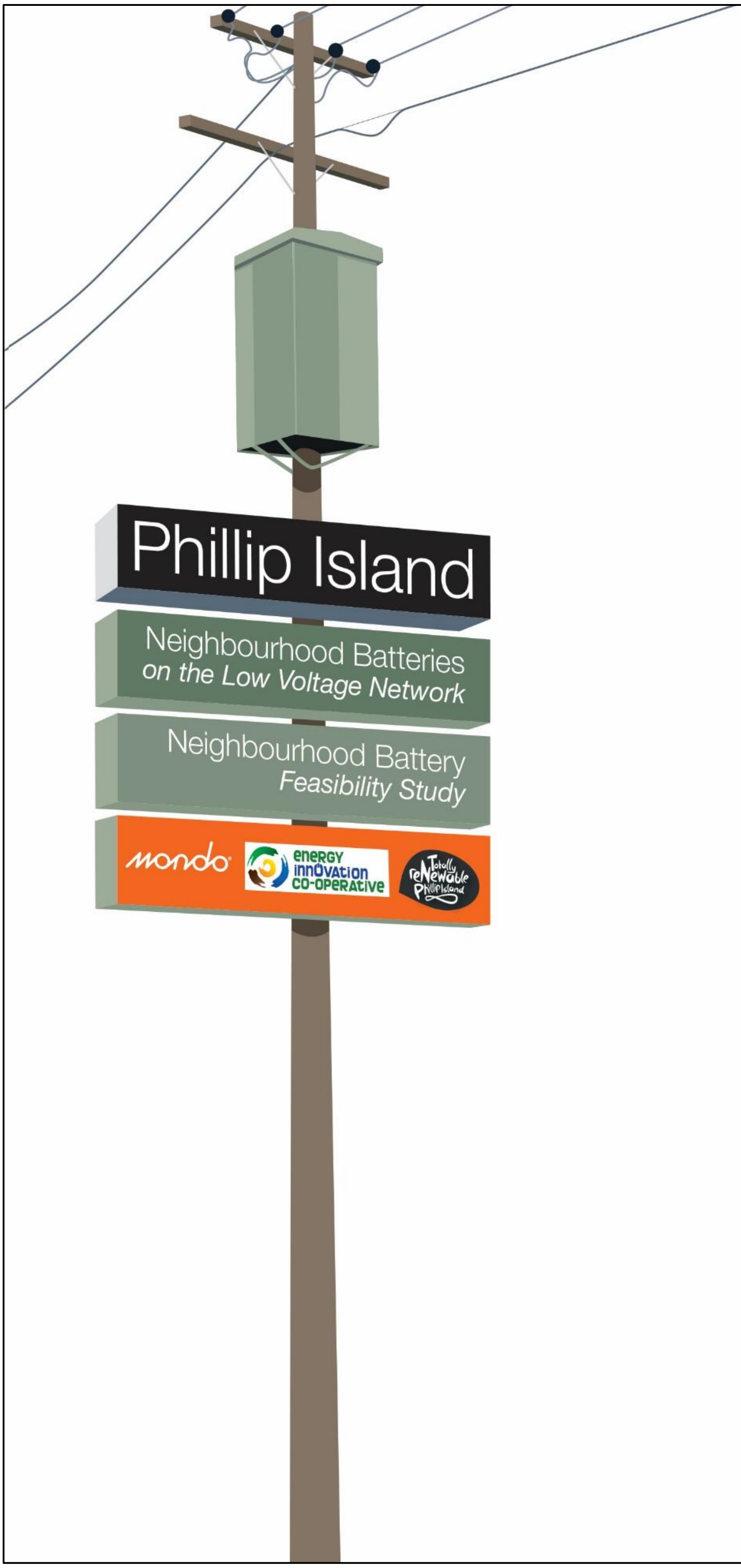
Phillip Island
Neighbourhood Batteries
on the Low Voltage Network
Neighbourhood Battery
Feasibility Study
mondo
energy innovation co-operative
Totally reNewable Phillip Island

Acronyms

Term	Definition
ACR	Automatic Circuit Recloser
BESS	Battery Energy Storage System
CES	Certificate of Electrical Safety
CFA	Country Fire Authority
DER	Distributed Energy Resources
DNSP	Distribution Network Service Provider
EICo-op	Energy Innovation Cooperative
ESS	Energy Storage System
EV	Electric Vehicle
FCAS	Frequency Control and Ancillary Services
LV	Low Voltage
kWh	Kilowatt hour
kVA	Kilo-volt amperes
kW	Kilowatt
NEM	National Electricity Market
NPV	Nett Present Value - the present values of all cashflows associated with the batteries (i.e. revenues, expenses etc. happening at different times throughout the lifespan of the batteries) as part of the commercial analysis
PUF	Plant Utilisation Factor
PV	Photovoltaic (Solar Panels)
SCADA	Supervisory Control and Data Acquisition
TRPI	Totally Renewable Phillip Island
V	Volts
VPP	Virtual Power Plant
WACC	Weighted Average Cost of Capital
Wh	Watt hour

1. Executive Summary

Energy Innovation Co-operative, Mondo and Totally Renewable Phillip Island have partnered on this exciting project with strong support from Bass Coast Shire Council to investigate community battery options for small communities and neighbourhoods in larger towns and cities.

Australia is undertaking an important energy transformation as part of its commitment towards cutting carbon emissions to net zero plan by 2050. Much of this transformation is being driven by households and business. There are also growing community-based initiatives for renewable energy including solar and wind supported by community batteries. Batteries are an important part of the transition to renewable energy and climate change action by storing renewable energy for use when generation is low. They are also important to address grid stability issues and energy reliability, including during and after bushfires and severe weather events.

This feasibility study examines the technical, commercial, social, environmental and financial feasibility of small batteries on the low voltage network on Phillip Island for their potential to support increased renewable energy generation and provide greater power supply reliability to the community. The project had a strong focus on community engagement to socialise the concept of community energy storage. Some aspects of the project were co-designed with the community. Technical, environmental, and commercial factors were also considered.

This research project will pave the way for residents and businesses in small neighbourhoods and communities to consider appropriately sized batteries to enable them to store and share their renewable energy. The project outcomes can be applied to small, isolated communities in Gippsland, other parts of Australia or in developing countries where smaller batteries are needed.

The technical analysis provided in the report shows that small neighbourhood batteries can enable renewable power sharing. They can also enable greater grid stability by soaking up excess solar energy entering the distribution network and reduce overloading on sub-stations.

Unfortunately, the commercial analysis showed this model of neighbourhood battery to not be financially viable. The high capital outlay cannot be realised within the life of the batteries. While battery prices are expected to reduce into the future, the required 60% reduction in capital outlay is unlikely in the foreseeable future to adequate to change the viability of the project.

The commercial findings have a serious impact on the potential battery ownership model. The project was hoping that a community ownership model would be possible to address social inequity in access to renewable energy. It was found that the high capital cost and low rate of return from power sales would make community ownership very risky. Third Party ownership may be more likely if the owners could unlock additional income by providing network services or gain financial benefit from avoiding or delaying network augmentation.

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2. Project Background

2.1 Introduction

Australia is in the midst of an important energy transformation as part of its commitment towards cutting carbon emissions to net zero plan by 2050.

Much of this transformation is being driven by the rapid uptake of Distributed Energy Resources (DER) across households and business. Reinforcing this uptake is a are growing number of community-based initiatives for solar and wind farm generation supported by community batteries. As of November 2021, Australia had more than 3 million rooftop solar PV systems installed across the country. This is the highest uptake of solar of any country globally. These changes will create a vastly different energy system to the one originally designed for fossil-fuel based generation via sources located many kilometres away from the point of consumption.

The role of community batteries is seen as important in supporting this increased solar take up whilst addressing related grid stability issues and important community-based energy reliability needs, in the face of bushfires and severe weather events. There is a growing interest in the role of community batteries which carry scale-based benefits and the ability to integrate more solar generation into the energy grid by increasing its “hosting capacity”. Under the right commercial models, community batteries may also offer more equitable access to a wider range of energy users by spreading the benefit of renewables access.

2.2 Project Partners

The following Project Partners secured funding from the Victorian Government under the Department of Environment, Land, Water and Planning (DELWP) Neighbourhood Battery Initiative (NBI) to undertake this feasibility study to identify the potential benefits of LV batteries within the Phillip Island community:

Energy Innovation Co-Operative (EICo-op) is the Lead Organisation and is a non-trading community volunteer not-for-profit co-operative with a mission of ‘working towards a zero emissions community’ to protect and enhance the natural environment. The EI Co-op has a 13-year history of managing grants and projects related to community owned renewable energy across Gippsland. These include:

- Solar array at the Wonthaggi Historic Coal Mine which sells power to Parks Victoria for the site
- Solar bulk-buy, home energy assessments
- Southern Core Public Fund provides no-interest loans to community not-for-profit organisations to switch to renewable energy
- Providing auspice services to new and emerging community energy groups across Gippsland, including Totally Renewable Phillip Island. www.eico-op.org.au

Totally Renewable Phillip Island (TRPI) is a voluntary collective of 15 members of local community organisations that have worked tirelessly together with the community and the power sector since inception in 2018 towards a shared vision of carbon neutrality by 2030. The members work across the issues of Carbon Accounting, Carbon & Regenerative Farming, Clean Energy, Community Education, Food & Waste and Clean & Green Transport. TRPI has significant social capital due to its structure and high profile in the community. This project will explore community and neighbourhood batteries as part of the pathway to 100% Renewable Phillip Island. https://totallyrenewablephillipisland.weebly.com

Mondo is a wholly owned commercial subsidiary of AusNet Services. They implement advanced energy management solutions for commercial, government and community partners. This includes specialisation in distributed energy services, microgrids and energy hubs, integrated energy platforms, transmission assets and metering.

Bass Coast Shire Council declared a Climate Emergency in 2019 and has set a Council and community target of zero net emissions by 2030. An extensive Climate Action Plan has been developed in consultation with the community. Council supports TRPI in its sustainability work through an annual grant and is also represented on the Project Governance Group.

The partners have known each other for varying lengths of time (1-13 years) and intensity through formal and informal networking. The partners self-selected based on the expertise required for this project. For example TRPI's social capital with the Phillip Island Community, Mondo's technical expertise including their Energy Network of the Future Team, especially with in-front-of-the meter projects.

2.3 Project Location

Phillip Island is located in Westernport Bay approximately 125 km south-southeast of Melbourne. The island is 26km long and 9km wide with an area of approximately 100km2. The island is connected to mainland Victoria by a bridge at San Remo/Newhaven. 60% of the island is sheep and cattle grazing farmland.

The permanent population is 10,387 which swells to 40,000 during summer. There is a main population centre at Cowes and several small hamlets are spread across the island. An estimated 50% of homes function as holiday homes and are unoccupied for much of the year.

The main economic driver for the island is tourism with many accommodation and hospitality providers. There is a strong community focus on the environment including vegetation and wildlife. The world-famous Penguin Parade is located on Phillip Island. There are large international events for car and motorbike racing at the Phillip Island Race Track and at the Phillip Island National Surfing Reserve.

2.4 Context and Structure of the Study

The COVID pandemic & lockdowns prevented face to face meetings of the Melbourne based and Phillip Island Project Group members. The application writing and preparation were conducted over 14 months without the project team ever meeting in person.

2.5 Project Governance

TRPI Core Group, EI Co-op and Mondo have a Memorandum of Understanding in place which outlines the roles and responsibilities of each organisation in relation to governance and management of this project. Representatives from each partner form the Project Group which has evolved into a co-governance group and a delivery team. The Group has met weekly throughout the life of the project to ensure delivery requirements are met, and at regular workshops to strategically analyse outputs and outcomes where the project delivery team requires input and higher-level decisions. Each Project partner is accountable to each other and to their individual organisation's governance and management structures. Partners' workshops were held at strategic points during the project to define technical, commercial, social, environmental and financial outputs and storage services. Initially there were significant organisational cultural differences between large corporate partners and those embedded in the community. These were resolved by respecting and focusing on each of the partner's commitment and their diverse but essential contribution to the project purpose and outcomes.

2.6 What is an LV Battery?

Low Voltage (LV) batteries are energy storage devices that operate at low voltages (typically around 415V-three phase) and connect to the LV part of the network for purposes such as:

- Peak demand support
- Storing excess solar generation for that part of the network
- Supporting overloaded LV substations to defer network augmentation and improve reliability of power supply

2.6.1 High Level Single Line Diagram

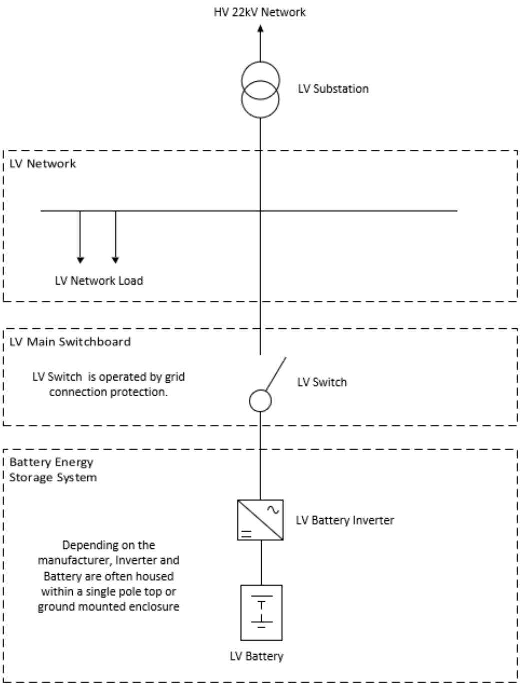

Figure 1: High level single line diagram of LV battery energy storage system

The LV battery energy storage system is connected to the LV network via the LV Main Switchboard. This connection can be located at any point in the LV Network, downstream of the selected LV substation.

The LV Main Switchboard houses the LV Switch which isolates the LV battery storage system from the grid. This LV switch can be operated by the grid connection protection, in the case of unsafe operation, or manually for the purpose of maintenance.

At the time of writing this document, there are two main types of battery configurations to consider for LV applications: ground-mounted and pole-top batteries. Both pole-top and ground-mounted batteries are viable options, each with their own benefits and drawbacks which are explored in this document.

Similarly, there are several different battery chemistry technologies to consider. This feasibility report will look specifically at lithium-ion batteries, however, refer to Battery Technology Comparison in this feasibility report for a high-level comparison of Na-ion and Li-ion technologies.

2.7 Project Objectives and Outcomes

This feasibility study explores the social, environmental, technical, and commercial benefits and considerations of LV Neighbourhood batteries (installed in-front-of-the meter) within Phillip Island. The proposed LV Neighbourhood batteries attempt to address two network issues faced by the Phillip Island community.

The first network issue arises from the high penetration of rooftop solar. High levels of solar exports can lead to grid capacity constraints caused by increasing voltage levels beyond the desired network range. This can lead to solar generation curtailment, which in essence means the excess solar energy is wasted. LV Neighbourhood batteries offer a potential solution to this problem by storing the high solar exports during sunny hours and enable its usage later in the day.

The second network issue is caused by increased energy demand beyond the rating for many of the distribution transformers. This leads to overloading which can put undesired pressure on the equipment resulting in potential accelerated degradation or damage. One solution to this problem is to upgrade the transformers, however this is an expensive solution and could lead to a solution that is oversized for the majority of the time. LV Neighbourhood batteries are able to target periods of peak demand, easing the pressure on network infrastructure, whilst providing additional benefits like the ones mentioned above.

3. Community Engagement

3.1 Objectives/Strategy

Community engagement was a core part of the feasibility study to ensure that proposed outcomes would be accepted and supported by the community in the near future. This included a series of actions, messages and engagements with different sectors of the community to discuss the context, opportunities and benefits of neighbourhood batteries. A summary of the Community Engagement Plan can be found at The Community Engagement Plan.

3.1.1 Purpose of the Community Engagement Strategy

The Project Control Group worked closely together to deliver a sequence of communications and engagement participatory activities. This ensured that the community was meaningfully engaged with appropriately framed information and opportunities to participate.

The purpose was to keep the community informed about the project without raising unrealistic expectations. It was important that we were seen as providing credible, balanced information while acting on our aspirations. The engagement of the community was carefully managed, to maintain their engagement and support of the project overview and intentions.

The Community Engagement Plan outlines activities to be undertaken to inform, engage, involve and empower local communities and stakeholders in preparation for and during the Neighbourhood Battery Initiative Low Voltage Battery Feasibility Study. It outlines the different engagement and communication methods planned to be used with a range of local stakeholders and ensured they were informed and had an opportunity to contribute to the project.

The main objective of this Community Engagement Strategy was to garner broad community input and involvement in the development and implementation of the feasibility study through:

- Development of a broad community awareness and acceptance of the battery project
- Facilitate multiple avenues for engagement and involvement, tailored to different parts of the local community
- Provide opportunities for community members to identify opportunities for future renewable energy development to achieve the vision 100% Phillip Island renewable energy
- Identify potential roles and opportunities for collaboration for different stakeholders
- Identify challenges, concerns, limitations or desired caveats for the battery project.

3.1.2 Background Context

Our energy system is changing by shifting from centrally located coal produced power to decentralised locally produced renewable energy generation, together with an increase in distributed energy storage. Batteries are part of that shift. Some batteries are behind-the-meter, located on people's property. Other batteries are in-front-of-the-meter which connect directly to the main distribution network, enabling them to receive and store power and then send the power out to the community when it is needed.

Battery storage enables excess renewable energy to be stored for use at another time, such as at night and on overcast days when solar generation is reduced or when the wind does not activate wind turbines. In-front-of-the meter batteries provide storage capacity for solar power generated by community members and then sold to the same and/or different customers. This 'virtual storage' will give participants access to the benefits of an energy storage system without needing to pay the upfront battery costs. Cost is a major barrier to members of the public purchasing their own battery and getting full value from the renewable power they generate.

Phillip Island is a world-renowned tourist destination due to a vast array of nature experiences and the world class race track. Large fluctuations of power use occur during high tourist seasons throughout summer, public and school holidays and during major events. The power use of the permanent population is relatively modest. The existing power distribution network struggles to meet the demand at peak seasons. More homes are installing solar panels, and this is causing problems for the distribution network.

Small batteries located around neighbourhoods can soak up the excess solar from the neighbourhood before it moves around the network. That power can then be used within the neighbourhood to reduce some of the power demand on the grid. It is a similar concept to the large battery also being installed on Phillip Island but at a smaller scale. The Low Voltage Feasibility study will examine the opportunities and challenges of this scale of energy storage. As this is a feasibility study, batteries will not be installed as part of this project.

The identified potential outcomes of the low voltage battery study were:

- Enable locally generated power to be shared across the local neighbourhood
- Reduce the use of the distribution network and maintenance costs
- Save power lost during transmission from distant central power stations
- Reduce environmental emissions to help mitigate climate change
- Energy trading between residents in the neighbourhood
- Allow increased renewable generation on the island without further destabilising the local distribution network
- Benefit other small communities with similar power supply problems through the study report
- Evaluate data about the battery operation to refine the technical and business model to benefit other communities
- Explore regulatory barriers to community renewable power distribution decisions

The feasibility study encouraged:

- Co-design with the community – to provide them with information and listen to their ideas
- A sense of community, purpose, empowerment and collective achievement for householders, business owners and partner organisations from co-designing solutions towards our local goal of 100% renewable and carbon neutral by 2030 to address the declared climate emergency
- Increased social cohesion from working together to resolve inequitable access to renewable energy and constraints on who can install and export excess solar energy
- Community engagement and ownership of the process and the renewable energy outcome
- Strong working collaboration between business, government, community members and leaders

- Community support for the achievement of existing regional objectives (including those of community groups, local businesses and local and state government)
- Broader community involvement in conversations, planning and action on energy costs, sustainability, security, reliability and justice.

The 15 Totally Renewable Phillip Island member organisations are embedded in the Phillip Island community, with extensive, long-term networks and relationships with thousands of local residents, holiday home owners, businesses and local organisations. The engagement and communications strategies made good use of these networks to engage the Phillip Island community in this project.

3.2 Key Messages

In engaging with the community it was critical that we had consistent messages to explain clearly how the concepts of battery storage and how this could provide benefit to the community at neighbourhood level. The core messages communicated are described below.

3.2.1 Battery Locations

10 substation locations were chosen across the island in Rhyll, Smiths Beach, Ventnor, Newhaven, Cape Woolamai and Cowes. They were selected based on data that indicated potential problems from very high solar generation and/or very high-power use.

Bass Coast Shire Council was involved in the site selection and provided information about the impact of vegetation on pole selection and the impact of using nature strips to locate ground mounted batteries. Council also provided vital information about social characteristics of the neighbourhoods serviced by the substations.

3.2.2 When Did the Project Happen?

The feasibility study was funded from August 2021 until 26 August 2022. The community may not have been aware of project staff visiting the substations to check environmental characteristics. Other research was performed in the office and through contact with local organisations. No installation work was associated with this feasibility study.

3.2.3 How Would the Batteries Work?

The uptake of solar by Phillip Island residents has been very positive. But the existing power distribution network was not designed to have so much power entering from so many sources and moving about. This causes network disruption on days of high solar generation. The feasibility study examined how low voltage batteries might take up the excess power to stabilise the network during peak periods and then enable the power to be used later.

The study also examined how households and businesses might be able to take greater advantage of their rooftop solar systems by storing their excess solar energy for use at another time, such as at night and on overcast days when solar generation is reduced, when the wind does not activate wind turbines, or during network power disruptions.

How these two benefits might provide reduced reliance on grid power to reduce environmental emissions from coal fired power generation was also examined.

Participants may experience similar benefits as behind-the meter batteries without incurring the upfront cost. Behaviour change education for the community to reduce electricity use was also examined to support the community to make best use of the available renewable power, particularly during power outages. Understanding the need for and type of community education e.g., load management and other actions, may result in a more reliable power supply for the whole community.

3.2.4 Safety

Mondo and its parent company AusNet Services have a strong culture and focus on safety with a Zero Target for injuries and incidents. This target has resulted in an enviable safety record and culture and is achieved through its embedded Infrastructure Quality Assurance program. Safety systems must be compliant to applicable standards including but not limited to AS 3000 and AS 5139.

This is overlaid with a highly regulated operating environment where Mondo is required to comply with regulations as defined by the Essential Service Commission and the Australian Energy Regulator.

Mondo routinely delivers major infrastructure projects that connect new assets to the network, including scaled, wind and solar farms, desalination plants and new commercial, residential and commercial developments. Mondo has also completed a range of community focused renewable energy projects, demonstrating capability at the residential scale, this includes being a key partner in the award-winning efforts in Yackandandah, and major projects in Euroa, Deakin University. They are familiar with the equipment to be studied as part of the project and the associated Australian Design standards including risks and mitigation solutions. Examples are specified fencing, exclusion zones, visual protection and appropriate signage.

Neighbourhood safety requirements of the battery installation will be considered in the study, including:

- Safe road access at potential battery sites for installation, maintenance and safety inspections
- Battery materials to prevent overcharge and over temperature
- Mechanisms to prevent and minimize damage from fire
- Mechanisms to safely evacuate personnel
- Engagement with Emergency Services personnel – Police, Country Fire Authority (CFA), State Emergency Service (SES) to discuss specific safety risks and remediation.

3.2.5 Neighbourhood Amenity

- Appearance – The feasibility study looked at community views on the appearance of the batteries which is akin to a metal cupboard on a power pole or on the ground. It also sought community views on the potential removal or replacement of large vegetation for safety reasons. Bass Coast Shire Council's views were also sought on removal, replacement and offsetting in this situation
- Environmental Assessments including the potential effect of the chemical contents of different types of batteries were also reviewed in the study
- Potential resident issues such as loss of parking from ground mounted batteries, and other health and safety concerns were also studied.

3.2.6 How the Community Could be Involved

Community involvement in the project built a sense of community empowerment and ownership for householders, business owners and community and partner organisations. It also increased social cohesion from working together to resolve inequitable access to renewable energy and constraints on who can install and export excess solar energy in the near future.

This document includes the strategies to engage the community in the study and help co-designing the solutions. For example:

- Energy use behaviours that align with the technical aspects of the battery, the best ways to achieve sustainable energy behaviour change
- New behaviours that best accommodate participants, technical and economic needs
- Financial and economic models that make the best use of energy for the community
- Benefit sharing options that are socially acceptable to residents and businesses

3.2.7 Target Audience

- Bass Coast Shire councillors and their staff
- Community - Phillip Island residents, organisations and holiday home owners
- Businesses
- Other like-minded communities and community energy groups.

3.3 The Community Engagement Plan

The Community Engagement Plan outlined multiple approaches to engage a broad cross-section of the community as part of the feasibility study and to improve general awareness of community benefit from battery projects. These approaches were referred to and adapted throughout the feasibility study, with successful application across the majority of approaches as well as some opportunistic engagement. The adaptations to the Community Engagement Plan and key learnings are addressed here.

3.3.1 The Community Engagement Plan

The Community Engagement Plan *(Table 1)* was prepared to assist in the community engagement component of the feasibility study.

Communication Mode	Sub-mode	Frequency	When	Message
Public Events	Markets	When available	Ongoing throughout	Announce the Project Project updates, next steps Where to get more information Survey link
	Street stalls	High tourist weekends		
	Project Launch	Once with live stream	Feb-March 2022	
	Public meetings/workshops, e.g. International Women's Day breakfast (Council hosted) Tuesday 8th March	Once with live stream	March-April 2022	
	Conference presentations e.g. LVA Community S3 Energy Group	Opportunistic		
Graphically designed print media materials	Local paper	Bi-monthly	March-Aug,	Announce the Project Project updates, next steps
	Project specific information leaflets/postcards left in key locations in main towns,	Minimum 3 beginning,	Ongoing throughout	

Communication Mode	Sub-mode	Frequency	When	Message
	e.g. cafes, library, council customer service areas	middle end of project Regularly replenish supplies at shops		Where to get more information Survey link Advertise the public events
Social media	Totally Renewable Phillip Island, Energy Innovation Co-operative, Mondo Bass Coast Shire Council	Weekly	Ongoing throughout	Same stories as newspaper Announce the Project Project updates, next steps Upcoming events Where to get more information Survey link
Website	Totally Renewable Phillip Island, Energy Innovation Co-operative, Mondo Bass Coast Shire Council	Monthly	Ongoing throughout	
Small group meetings	Bass Coast Shire Councillors	Only if they respond to email	April-May	Announce the Project
	Totally Renewable Phillip Island members & staff	Once		Short presentations & discussion - details of the project Survey link
Small group meetings	Local state and federal members of parliament	Only if they respond to email	April-May	Short presentations & discussion - details of the project Announce the Project
	Community Energy Networks e.g. BCCAN, GCCN, Sandy Point, Venus Bay, Yarram, Just Transition South Gippsland face to face or via Zoom	Only if they respond to email		Short presentations & discussion - details of the project
	Traditional Owner Groups	Only if they respond to email		Short presentations & discussion - details of the project. Survey link
	Local Business Groups & Networks	Once	22nd Feb	Short presentations & discussion - details of the project. Survey link

Communication Mode	Sub-mode	Frequency	When	Message
Emails & Newsletter	Project partners & stakeholders Local & federal members of Parliament Bass Coast Shire Councillors Community Energy Networks Traditional owner groups	Throughout	February - June	Distribute general project information, notice of opportunities to contribute, e.g. notice of community events, survey link.
Online surveys	Survey monkey with links on social media & website, newspaper articles	Once	March	Co-design questions
Engage Victoria consultations	Online survey questions	Once	March-April	Co-design questions

Table 1: Community Engagement Plan

3.3.2 Adaptations and Key Learnings

Most approaches in The Community Engagement Plan were followed through. The feasibility study was forecast by a series of 5 newspaper articles in January 2022. Community benefits from neighbourhood battery projects, and broader community education was consistently messaged at other events, community conversations and public speaking opportunities. The cross-integration of different approach platforms was successful, for instance integrating articles in local papers with social media posts and promotion across speaking events (e.g. the Bass Coast Shire hosted International Women's Day breakfast event and associated media articles).

Due to the ongoing context of social impacts and disruptions from the COVID-19 pandemic, flexible strategies were applied to engage target groups to share information on the battery projects. More formal outreach approaches (e.g. Engage Victoria consultations) were downscaled in favour of more direct grassroots outreach through market stalls (when available) and online forums with direct community Q&A sessions. The reach of TRPI's network of 15 member groups allowed for broad information sharing and the uptake of respondents to TRPI's 'Neighbourhood Battery Survey'.

A key learning was allowing a consistent yet flexible approach to messaging which resulted in additional opportunities to discuss the battery projects and feasibility study at grassroots, business and organisation, partner group, Council, and even at community level with other communities interested in the community energy journey.

3.4 Neighbourhood Battery Survey and Results

3.4.1 Introduction to Neighbourhood Battery Survey

The Neighbourhood Battey Survey was prepared and distributed by Totally Renewable Phillip Island via their Facebook page, TRPI newsletter, and newspaper articles. The survey was originally open on Google Forms from 28 February 2022 to 19 April 2022 and received 55 responses. However the survey remained open to accept additional responses until 5th May 2022, at which point 67 responses were received in total.

The report and analysis below include the full 67 response data. The original report is available for viewing on request via totally.renewable.phillip.island@gmail.com and reflects the results of the initial 55 respondents.

3.4.2 Summary of Key Findings

There were 9 questions posed which related to existing household solar panels and battery storage, social equity and energy sharing, as well as support and responses to smaller neighbourhood batteries on Phillip Island.

The key findings in relation to the survey questions are summarised below:

- The majority of participants are permanent residents and want to stay updated or contribute via surveys to ongoing TRPI activities, and would like to know more or consider taking part in a neighbourhood small battery trial on the Island
- The majority of participants have solar panels on their house with 25% producing more than they need and 35% still needing to buy power from time to time
- 95% of participants said YES or MAYBE to consider donating a portion of their excess solar to others in the community to increase social equity
- 58% of participants would like to have a home battery storage system to use with their household solar panels to be able to use the solar power at night - but it is too expensive
- 64% of participants can't wait to see local storage and household production of renewables take off on the Island
- 88% of participants feel that smaller battery storage at neighbourhood level will encourage more people to generate renewable energy at household level.

3.4.3 Survey Participants

The majority of participants are permanent residents and want to stay updated or contribute via surveys to ongoing TRPI activities; and would like to know more or consider taking part in a neighbourhood small battery trial on the Island.

- A total of 67 responses received as at 5th May 2022
- 80% of respondents live on Phillip Island permanently
- An additional 10% of respondents live on Phillip Island weekends or holidays
- 59% of respondents have visited the TRPI webpage
- 66% of respondents want to be involved with TRPI through regular updates of events and activities
- 78% of respondents are happy to answer short surveys to contribute opinions
- 73% of respondents said YES they would like to know more or take part in the trial
- An additional 25% of respondents said MAYBE they would like to know more or take part in the trial (total 98% of respondents showing interest)
- 54 participants provided emails to receive updates specific to the neighbourhood battery initiative

3.4.4 Solar Energy Household Production and Usage

The majority of participants have solar panels on their house with 25% producing more than they need and 35% still needing to buy power from time to time.

- A total of 70% of respondents have solar panels on their house
- Of these, 35% of respondents have solar panels and still need to buy power from time to time
- Of these, 9% of respondents have the right amount of solar panels for household needs

- Of these, 25% of respondents have solar panels and produce more solar energy than is needed and could export it
- 16% do not have solar panels but are thinking of installing
- 7% do not have access to solar panels as they are renting / pay additional for renewable energy supply
- Other individual responses report being off-grid, or having too many trees/ unsuitable roof for installing solar panels

3.4.5 Social Equity

95% of participants said YES or MAYBE to consider donating a portion of their excess solar to others in the community to increase social equity.

- 65% of respondents said YES - if they could produce more rooftop solar power than they needed, they would consider donation a portion of it to others in the community to increase social equity
- 30% of respondents said MAYBE - if they could produce more rooftop solar power than they needed, they would consider donation a portion of it to others in the community to increase social equity.

3.4.6 Battery Storage at Household Level

58% of participants would like to have a home battery storage system to use with their household solar panels to be able to use the solar power at night - but it is too expensive.

- 9% of respondents have household solar panels and battery storage
- 58% of respondents would like to have home battery storage but they are too expensive
- 9% of respondents are waiting to purchase an electric vehicle to use as a home battery system

3.4.7 Support for Smaller Neighbourhood Batteries

64% of participants cannot wait to see local storage and household production of renewables take off on the Island.

- 64% of respondents cannot wait to see local storage and household production of renewables take off on the Island
- 47% of respondents support having smaller batteries in different neighbourhoods across the Island provided they can use the energy stored in the battery for their own house needs first
- 26% of respondents support neighbourhood batteries for trading energy and earning income
- 32% of respondents only support the neighbourhood batteries if they are community owned
- 14% of respondents do not understand how neighbourhood batteries would work for them
- Other individual responses report concerns around the safety of batteries near houses, and environmental impact including noise
- NO respondents DO NOT support neighbourhood batteries or believe neighbourhood batteries will not change how the electricity system works

3.4.8 Response to Smaller Neighbourhood Batteries

88% of participants feel that smaller battery storage at neighbourhood level will encourage more people to generate renewable energy at household level.

- 88% of respondents feel that smaller battery storage at neighbourhood level will encourage more people to generate renewable energy at household level
- 67% of respondents feel they will stabilise the grid in their neighbourhood
- 79% of respondents see the benefits in offering local renewable energy to those locally who cannot access it easily
- 59% of respondents feel they would be useful in weather extremes as a local source of ‘emergency’ back-up power
- 9% of respondents are concerned about the appearance of batteries in neighbourhoods; 11% are concerned about the possibilities of fires and noise
- NO respondents see NO benefit in sharing locally produced renewable energy

4. The Environment

Protection of the natural environment is a very strong part of the social culture of the Phillip Island community. This includes wildlife, vegetation, cultural and historic protection. In addition to many individual residents and visitors, environment protection is central to Totally Renewable Phillip Island members, including Energy Innovation Co-operative, Phillip Island Nature Parks, Phillip Island Conservation Society, Landcare and Bass Coast Shire Council.

Planning Overlays that were all considered in the analysis of individual sub-station sites and are described in Review of Proposed LV Battery Locations of this report, including:

- Aboriginal Cultural Heritage Sensitivity Design and development overlay (DDO)
- Environmental significance overlay (ESO)
- Significant landscape overlay (SLO)
- Bushfire Prone Area Classification and Vegetation protection overlay (VPO),
- Potential Social/Community Impact
- Zoning Classification impacts to the community such as blocking intersection visibility, proximity to residential homes, visual impact and noise, land availability

4.1 Vegetation

Vegetation removal was considered in the analysis of individual sub-station sites. Bass Coast Shire Council advised that vegetation pruning for safety reasons is acceptable in this context. They also advised that vegetation removal in this context would require a permit for private land, but not for public land such as nature strips. Vegetation replacement of indigenous species at the site or a different site is strongly encouraged.

4.2 Wildlife Protection

The DELWP Wildlife policy team (Biodiversity Division) provided the following advice regarding protection of wildlife on 28 July 2022:

> Thank you for contacting CCC about battery shielding requirements to protect wildlife.
>
> Under the *Wildlife Act 1975* it is an offence to harm wildlife, however wildlife injuring themselves by coming into contact with human appliances is not covered by this offence. These types of interactions are covered more broadly by the *Environment Protection Act 2017* (EPA). Section 25 of the EPA creates a general duty to minimise risks of harm to human health and the environment. This offence applies to everyone in Victoria, but only in the course of business activities or undertakings. Therefore, residential battery instalments by private individuals are not liable for risks created to the environment by exposed batteries from this duty, but the instalment of pole-mounted batteries publicly can be subject to this duty. This duty in practice is focused on protecting human health. The amount of protection wildlife has against injuring themselves on human installations is limited.

Notwithstanding this advice, the project team feels strongly that this risk should be considered and that attempts to prevent wildlife injuring themselves would be an expectation of the Phillip Island community.

Future Design Considerations also describes Wildlife Protection and Noise Limits.

4.3 Examination of the Potential Environmental Impacts of Low Voltage Batteries

Potential environmental impacts of LV Neighbourhood Batteries and measures to minimise risks associated with those impacts were considered and analysed as part of this feasibility study. Review of Proposed LV Battery Locations provides the review of proposed installation sites including vegetation clearance. There is a10m inclusion radius surrounding the LV Neighbourhood Batteries in bushfire prone areas on the island. This is to minimise the start of bushfires as well as bushfires affecting the battery electrical equipment. In addition, Design Requirements and Future Design Considerations of this feasibility study explain any design considerations to minimise hazardous risks of LV Neighbourhood Batteries such as electrical safety, appropriate enclosure and fencing to ensure wildlife protection, design compliance to Australian standards and manufacturer safety measures such as thermal and battery management system to prevent any electrical and fire risks (i.e., fire risks due to battery leakage, high temperatures etc.)

5. Technical Analysis

5.1 Substation Selection

5.1.1 Energy Data Analysis

The site selection for community batteries on Phillip Island used a thorough analysis of substation data for all the substations on the island. High substation loading and high solar photovoltaic penetration were the two factors which were used for selection of substations suitable for LV Neighbourhood batteries.

Substations with high loading were identified by analysing their power utilisation factor (PUF) data for January and July in 2021 (peak summer and peak winter month – months with relatively higher power consumption). The substations were ranked in descending order of maximum loading which was calculated by taking the higher of the two month's estimated loading.

The substations were also ranked in descending order of solar photovoltaic penetration. This metric was estimated by dividing the total installed PV on a substation by the substation rating. This normalisation was necessary as the size of the substations on the island ranged between 50kVA and 315kVA.

Initially, the top 40 substations were determined by choosing the 25 substations with the highest maximum loading and highest PV penetration. The substation network data for the Wonthaggi feeder was obtained at a later date, therefore, an additional 15 substations from the Cape Woolamai area were chosen using a similar methodology. Each substation was given an identifier comprised of a number from the list of 40 substations being considered and the name of the area, shown in the map in Figure 4: Substation Location Overview.

The list of top substations was further narrowed down to the final 10 candidates in a workshop between Mondo and EICo-op/TRPI. In this workshop, the substations were selected based on a combination of technical data, geographical location and social aspects provided by the community groups as shown on Figure 4: Substation Location Overview.

The substations shortlisted either experienced significant reverse power flow issues, particularly in the spring and summer months, and one (12-Cowes) was found to have significant overloading particularly in the winter months.

The figures below represent the substation annual energy data for 2019 for 37-Cowes (*Figure* 2) and 12-Cowes (*Figure* 3) in order to illustrate these two network issues (reverse power flow and overloading). The graphs show the average power demand (**blue curve**), maximum power demand (**orange curve**), minimum power demand (**grey curve**), and the substation power rating (**yellow curve**) for each of the substations.

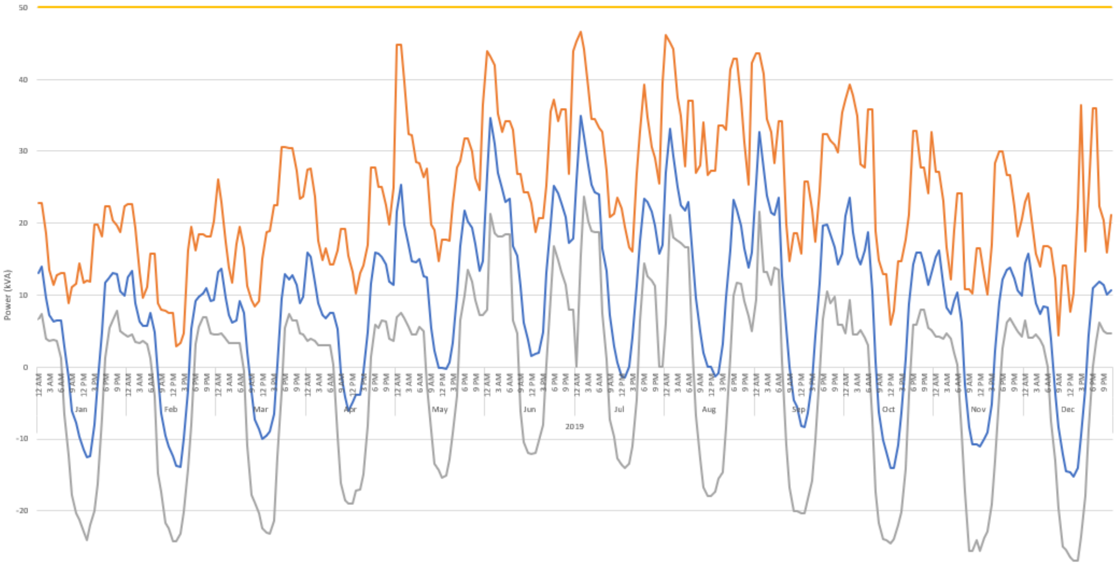

Figure 2: Annual energy data with high solar exports (2019)- 37 Cowes

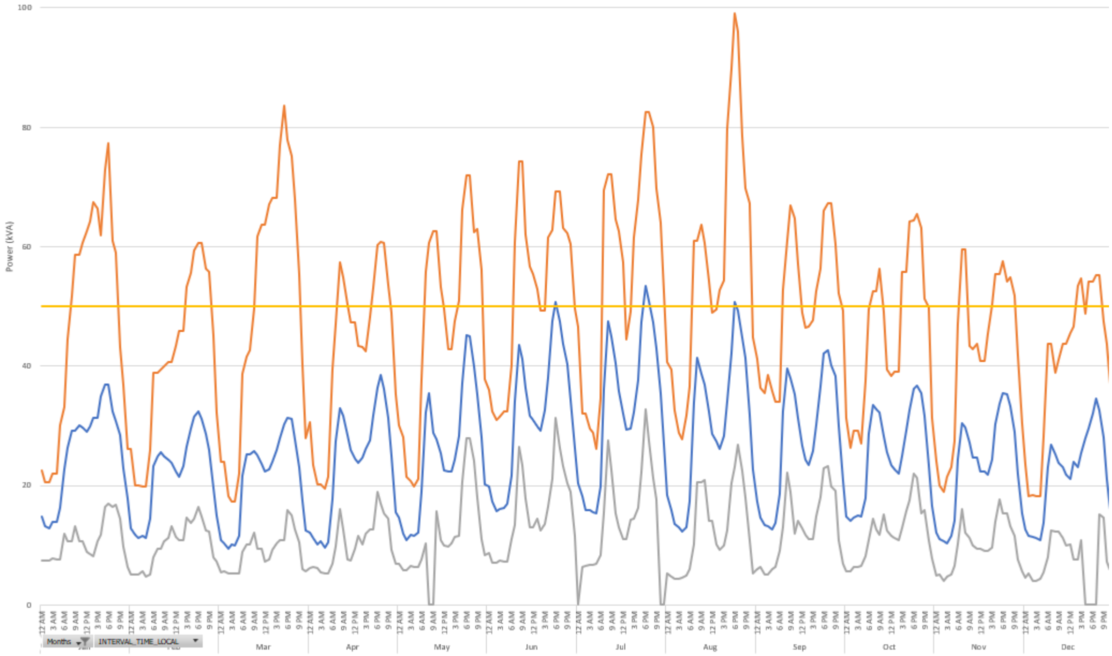

Figure 3: Annual energy data with high overloading (2019)at 12-Cowes

It can be observed that substation 37-Cowes (*Figure* 2) recorded high solar exports throughout the year (seen in the grey curve) - solar exports are recorded in the data as negative numbers. Alternatively, substation 12-Cowes (*Figure* 3)recorded high overloading (orange curve) throughout the year – which is when the power consumption exceeds the substation rating (yellow curve). LV batteries could address and utilise the higher solar exports throughout the day by charging (acting as a load) and address the overloading issues by discharging (acting as a generator). When selecting the shortlisted sites and the sizing of the LV batteries, the following criteria were analysed: high installed solar capacity, high solar exports, and overloading of each site.

5.1.2 Overview of Selected Substations within Phillip Island

Figure 4: Substation Location Overview

5.2 Battery Sizing Approach

5.2.1 Methodology

The sizing of the ten LV Neighbourhood batteries comprised of analysing LV substation energy data for 2019 and 2021 and understand consumption profiles and solar power exports for each substation. 2020 was classified as an outlier year due to unusual power usage patterns affected by Covid-19 pandemic and therefore its load data was excluded from this analysis.

Based on the outcomes from the energy analysis, the LV Neighbourhood batteries can be sized to address one or more of the following (depending on configuration):

- Storing the excess solar power generation at LV substation level, increasing renewable energy consumption/utilisation on the island.
- Avoid LV substation overloading to improve power reliability and avoid power outages due to high loading.
- Provide power during outages at a LV substation level. This is referred to as "Islanding" within this report.

These three conditions are explained in more detail in the following sections of this report.

5.2.2 Storing Solar Exports

The capacity of the LV Neighbourhood batteries can be sized to allow for excess solar generation to be stored at a substation level. This capacity was determined by taking the average of the average daily solar exports and the highest daily solar exports in 2021, shown in Table 2: LV Neighbourhood Batteries' Capacity for Solar Exports. For example, the required battery capacity of 30-Rhyll for storing solar exports is the average of 58.70 and 186.37, which is equal to 122.5.

This approach will enable higher solar hosting capacity in the future and provide improved solar utilisation throughout the island. The sizing was conducted by using the 2021 LV substation load data in order to capture the most recent and higher daily solar exports in terms of daily energy exported (kWh) compared to the daily solar exports in 2019.

The results of the solar exports analysis for the 10 chosen sites are showing that sites 30-Rhyll, 12-Newhaven, 3-Cape Woolamai, and 39-Cowes have experienced higher solar exports in comparison to the other sites and hence larger storage capacity is required to better utilise the excess solar generation. On the other hand, site 12-Cowes has experienced the lowest solar export caused by frequent overloading throughout the year which results in negligible storage capacity required to utilise excess solar generation.

The results of this analysis are shown in *Table 2 (below)*.

Substation number and area	Total Solar installed (kW)	Average daily solar exports 2021 (kWh)	Highest daily solar exports 2021 (kWh)	Required Battery capacity for solar exports (kWh)
30 – Rhyll	66.26	58.70	186.37	122.54
4 – Smiths Beach	30.14	18.04	82.20	50.12
2 – Ventnor	26.61	30.77	94.53	62.65
12 – Newhaven	81.30	37.23	169.19	103.21
3 – Cape Woolamai	150.40	114.84	441.88	278.36
8 – Cape Woolamai	52.36	18.54	78.14	48.34
32 – Cowes	60.82	16.90	74.80	45.85
37 – Cowes	45.94	47.12	152.10	99.61
12 – Cowes	25.97	1.03	2.08	1.56
39 – Cowes	60.13	71.20	243.60	157.40

Table 2: LV Neighbourhood Batteries capacity for solar exports

5.2.3 Substation Overloading

The capacity of the LV Neighbourhood batteries can be sized to address overloading issues at a LV substation level. This was determined by taking the average substation overloading levels beyond its rated capacity for 2019 and 2021. This approach aims to improve power reliability, avoid network augmentation, and power outages due to high loading.

The results of the substation overloading analysis for the 10 chosen sites show that overloading is not a significant issue on the island, with the exception of 12-Cowes and 32-Cowes.

The results of this analysis are shown in *Table 3*:

Substation number and area	Maximum overloading 2021 (%)	Average overloading daily capacity 2019 (kWh)	Average overloading daily capacity 2021 (kWh)	Required Battery capacity to address overloading (kWh)
30 – Rhyll	87.80%	0	0	0
4 – Smiths Beach	81.10%	0	0	0
2 – Ventnor	101.80%	2.75	0	1.38
12 – Newhaven	113.20%	2	1.75	1.88
3 – Cape Woolamai	75.20%	0	0	0
8 – Cape Woolamai	93.20%	0	0	0
32 – Cowes	114.80%	12.9	17.6	15.25
37 – Cowes	109.70%	0	1.6	0.8
12 – Cowes	177.30%	23.7	21.6	22.65
39 – Cowes	92.10	0	0	0

Table 3: LV Neighbourhood Batteries capacity to address substation overloading

5.2.4 Islanding Capability During Power Outages

The capacity of the LV Neighbourhood batteries can be sized to allow for islanding capability during power outages. The required battery capacity to enable islanding at each individual substation was determined by analysing the average power outage duration for each of the feeder supplying the LV substation at the average power consumption level using the 2019 and 2021 LV substation load data.

The results of the analysis for islanding capability during power outages for the 10 chosen sites show that sites 12-Newhaven, 3-Cape Woolamai, 8-Cape Woolamai, 32-Cowes require larger storage capacity to provide reliable power supply during power outages in comparison to the other sites. The cause of the statement above is higher number of customers connected on those LV clusters and hence higher power consumption throughout the year.

The results of this analysis are shown in Table 4: LV Neighbourhood Batteries' Capacity with Islanding Capability.

Substation number and area	Substation rating (kVA)	Name of Feeder	Average Power Outage duration per event (hours)	Required Battery capacity for islanding (kWh)
30 – Rhyll	100	PHI11	3.45	46.24
4 – Smiths Beach	100	PHI12	3.35	45.76
2 – Ventnor	50	PHI12	3.35	31.84
12 – Newhaven	100	WGI32	3.54	110.64
3 – Cape Woolamai	315	WGI32	3.54	296.20
8 - Cape Woolamai	315	WGI32	3.54	172.62
32- Cowes	200	PHI13	2.78	147.64
37 – Cowes	50	PHI13	2.78	24.51
12 – Cowes	50	PHI13	2.78	68.03
39- Cowes	100	PHI13	2.78	68.13

Table 4: LV Neighbourhood Batteries capacity with islanding capability

5.2.5 Battery Capacity Overview

Table 5: Battery Capacity Overview provides a summary of the battery sizing results for each sizing method.

Substation number and area	Required Battery capacity for solar exports (kWh)	Required Battery capacity to address overloading (kWh)	Required Battery capacity for Islanding (kWh)
30 – Rhyll	122.54	0	46.24
4 – Smiths Beach	50.12	0	45.76
2 – Ventnor	62.65	1.38	31.84
12 – Newhaven	103.21	1.88	110.64
3 – Cape Woolamai	278.36	0	296.20
8 - Cape Woolamai	48.34	0	172.62
32- Cowes	45.85	15.25	147.64
37 – Cowes	99.61	0.8	24.51
12 – Cowes	1.56	22.65	68.03
39- Cowes	157.40	0	68.13

Table 5: Battery Capacity Overview

The Proposed Optimal Battery sizing outlined in this feasibility report have been selected to accommodate batteries that address excess solar exports and overloading criteria **only**. Islanding capability is excluded and therefore it is not considered when determining the proposed battery size for each location. The expected capital investment required to incorporate islanding capabilities into the LV battery solution was found to be disproportional to the expected benefits – therefore, it was found to not be a commercially viable option at this stage.

Refer to Technical Analysis and Commercial Analysis of this feasibility report for further details on future design and commercial considerations regarding islanding capabilities.

5.3 Review of Proposed LV Battery Locations[1]

The proposed battery location at each of the 10 selected LV substations was determined taking into consideration several potential influential factors, which include:

- **Battery mounting strategy**: Pole-Top or Ground-Mount
- **Land availability**: Depending on the battery size and mounting strategy, a portion of land may be required to enable the installation and operation of the LV Neighbourhood batteries
- **Vegetation**: Review of anticipated vegetation clearance required to enable the installation and operation of the battery within the specific location
- **Proximity to the LV substation**: This factor may affect the cable reticulation strategy to connect the battery to the LV substation (overhead or underground). The battery should be located as close to the LV substation as possible to avoid higher cable costs due to higher voltage drops
- **Planning Overlays:** Design and development overlay (DDO), Environmental significance overlay (ESO), Significant landscape overlay (SLO), Vegetation protection overlay (VPO), etc.
- **Bushfire Prone Area Classification:** A 10m inclusion radius surrounding LV Neighbourhood batteries applies based on current CFA guidelines. Any additional requirements must be met in line with the CFA's *Guidelines for Renewable Energy Installations*
- **Zoning Classification**
- **Aboriginal Cultural Heritage Sensitivity:** All or part of this property is an 'area of cultural heritage sensitivity'. Under the Aboriginal Heritage Regulations 2018, 'areas of cultural heritage sensitivity' are one part of a two-part trigger which require a 'cultural heritage management plan' be prepared where a listed 'high impact activity' is proposed. If a significant land use change is proposed (for example, a subdivision into 3 or more lots), a cultural heritage management plan may be triggered. One or two dwellings, works ancillary to a dwelling, services to a dwelling, alteration of buildings and minor works are examples of works exempt from this requirement
- **Potential Social/Community Impact (with inputs from EICo-op, TRPI and the Bass Coast Shire Council):** Considering impacts to the community such as blocking intersection visibility, proximity to residential homes, visual impact and noise, land availability.

Due to constrained market availability of Pole-Top batteries, when determining the technical solution, it has been assumed that the Ground-Mounted batteries are favourable solution when the required capacity to meet the excess solar exports and overloading criteria exceeds 75kWh.

30-Rhyll LV Substation

30-Rhyll Site Constraints / Considerations

- **Planning overlay:** Vegetation protection overlay (VPO)
- **Bushfire prone area:** No

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[1] As of June 2022

- **Zoning:** Public Park and recreation zone (PPRZ)
- **Aboriginal Cultural Heritage Sensitivity** – Yes

30–Rhyll Proposed Option

- **Mounting Strategy:** Ground-mounted
- **Location:** immediate proximity to LV substation.
- **Proposed connection**: Underground
- **Pros:** Short distance to LV substation, potentially resulting in less vegetation clearance and reduced costs associated with cable lengths.
- **Cons**: Some vegetation clearance required for battery footprint and trenching.

Figures 5 and 6 below provide a high-level overview of the proposed battery location for 30–Rhyll. The blue pointer denotes the existing LV substation, and the yellow polygon denotes the estimated battery location.

Figure 5: 30-Rhyll Proposed Option: Immediate proximity to the LV substation

Figure 6: 30-Rhyll Proposed Option: Street view

30-Rhyll Alternative Option

- **Mounting Strategy:** Ground-mounted
- **Location:** at the Rhyll Park, proximity to the LV substation is ~40m
- **Proposed connection**: Underground
- **Pros:** No expected vegetation clearance required for the battery footprint; abundant available space within Rhyll Park.

- **Cons**: Vegetation clearance may be required to allow for an underground connection to the LV substation. This is expected to incur additional costs associated with underground cable reticulation (trenching, conduits, cabling, etc)

Figure 7: 30-Rhyll Alternative Option – Rhyll Park provides a high-level overview of the alternative battery location for 30 – Rhyll. The blue pointer denotes the existing LV substation, and the yellow polygon denotes the estimated battery location.

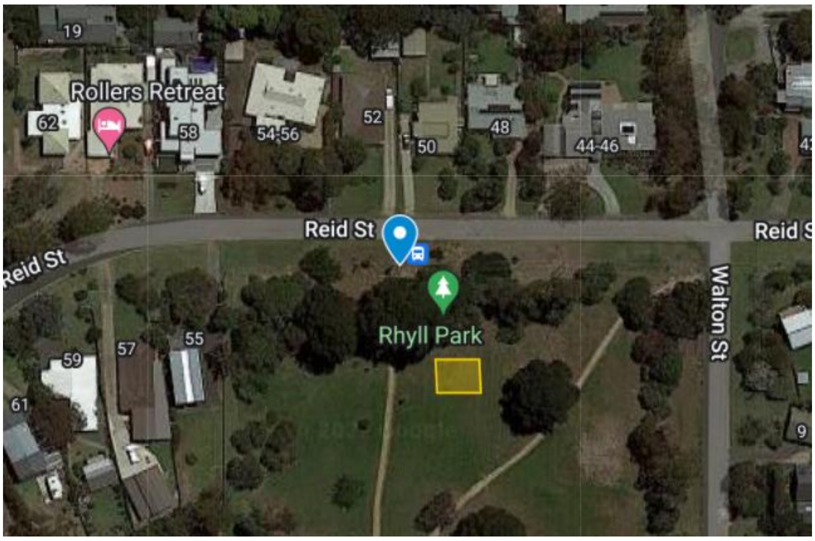

Figure 7: 30-Rhyll Alternative Option - Rhyll Park

4–Smith's Beach LV Substation

4-Smith's Beach Site Constraints / Considerations

- **Planning overlay:**
  . 'Design and development overlay (DDO): Smiths Beach Town Plan' includes an action to prepare a master plan for Mitchell Reserve to maximise the recreation opportunities and investigate the use of it as a seasonal overflow car parking. The proposed location of the ground mounted facility within the Mitchell reserve could prohibit what is intended for the reserve.
  . Environmental significance overlay (ESO)
  . Significant landscape overlay (SLO)
  . Vegetation protection overlay (VPO)
- **Bushfire prone area:** Yes
- **Zoning:** General Residential Zone 1 (GRZ1)
- **Aboriginal Cultural Heritage Sensitivity** – No

4-Smith's Beach Proposed Option

- **Mounting Strategy:** Pole-Mount
- **Location:** Pole adjacent to the existing LV substation pole (north). Distance approx. ~40m.
- **Proposed connection**: Overhead
- **Pros:** No land or vegetation clearance is expected to be required for the installation and operation of the battery.
- **Cons**: The size of the battery is limited to the maximum size of available pole-mounted batteries, which limits the opportunity for future expansion.

Figure 8: 4-Smith's Beach Proposed Option – Pole-top LV Neighbourhood Battery and Figure 9: 4- Smith's Beach Proposed Option – Street View provide a high-level overview of the proposed

battery location for 4 – Smiths Beach. The blue pointer denotes the existing LV substation, and the yellow pointer denotes the potential pole for the pole-top LV Neighbourhood Battery.

Figure 8: 4-Smith's Beach Proposed Option – Pole-top LV Neighbourhood Battery

Figure 9: 4-Smith's Beach Proposed Option – Street view

4-Smith's Beach Alternative Option

- **Mounting Strategy:** Ground-mounted
- **Location:** at the recreation park (west from the LV substation). Proximity to LV substation is approximately ~65m
- **Proposed connection**: Underground
- **Pros:** No size limitations on LV Neighbourhood Battery, allowing for future expansion if required
- **Cons**: Vegetation clearance may be required for the footprint of the battery. Similarly, vegetation clearance may be required to allow for an underground connection to the LV

substation. This is expected to incur additional costs associated with underground cable reticulation (trenching, conduits, cabling, etc).

Figure 10: 4-Smith's Beach Alternative Option – Ground-mounted LV Neighbourhood Battery provides a high-level overview of the alternative battery location for 4–Smith's Beach. The blue pointer denotes the existing LV substation, and the yellow polygon denotes the estimated maximum battery footprint of 10x10m. The final footprint is to be determined with the final LV Neighbourhood Battery sizing and 10m fire break area inclusion as per CFA guidelines.

Figure 10: 4-Smith's Beach Alternative Option - Ground-mounted LV Neighbourhood Battery

2–Ventnor LV Substation

2-Ventnor Site Constraints / Considerations

- **Planning overlay:** Bushfire management overlay (BMO)
- **Bushfire prone area:** Yes
- **Zoning** Public Park and Recreation Zone (PPRZ)
- **Aboriginal Cultural Heritage Sensitivity**: Yes

2–Ventnor Proposed Option

- **Mounting Strategy:** Pole-Mount
- **Location:** Pole adjacent to the existing LV substation pole (north). Distance approximately ~50m.
- **Proposed connection**: Overhead
- **Pros:** No major land or vegetation clearance is expected to be required for the installation and operation of the battery.
- **Cons**: The size of the battery is limited to the maximum size of available pole-mounted batteries, which limits the opportunity for future expansion.

Figure 11: 2-Ventnor Proposed Option – Pole-top LV Neighbourhood Battery and Figure 12: 2-Ventnor Proposed Option – Street View provide a high-level overview of the proposed battery location for 2 - Ventnor. The blue pointer denotes the existing LV substation, and the yellow pointer denotes the potential pole for the pole-top LV Neighbourhood Battery.

Figure 11: 2-Ventnor Proposed Option – Pole-top LV Neighbourhood Battery

Figure 12: 2-Ventnor Proposed Option - Street View

2-Ventnor Alternative Option

- **Mounting Strategy:** Ground-mounted
- **Location:** Potentially within the nature reserve (south-east from the LV substation). Proximity to LV substation ~25m
- **Proposed connection**: Overhead
- **Pros:** Relatively close in proximity to existing LV substation, resulting in reduced costs related to cabling. No size limitations on LV Neighbourhood Battery, allowing for future expansion if required.
- **Cons**: Significant vegetation clearance required for the footprint of the battery.

Figure 13: 2-Ventnor Alternative Option – Ground-Mounted LV Neighbourhood Battery provides a high-level overview of the alternative battery location for 2 - Ventnor. The blue pointer denotes the existing LV substation, and the yellow polygon denotes the estimated maximum battery footprint of 10x10m. The final footprint is to be determined with the final LV Neighbourhood Battery sizing and 10m fire break area inclusion as per CFA guidelines.

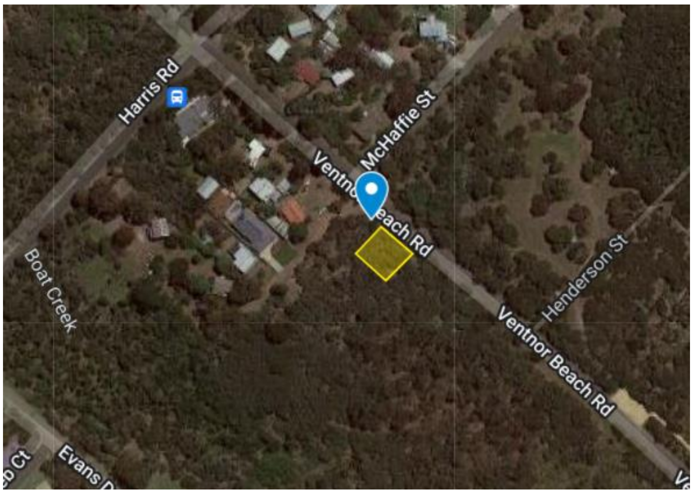

Figure 13: 2-Ventnor Alternative Option - Ground-mounted LV Neighbourhood battery

12-Newhaven LV Substation

12-Newhaven Site Constraints / Considerations

- **Planning overlay:**
  . Design and development overlay – Schedule 1 (DDO1) – only applicable for "Alternative Option"
  . Vegetation protection overlay – Schedule 2 (VPO2) – only applicable for "Alternative Option"
- **Bushfire prone area:** Yes - only applicable for "Alternative Option"
- **Zoning**
  . General residential zone – Schedule 1 (GRZ1)
  . Public Use Zone– Education (PUZ2)
- **Aboriginal Cultural Heritage Sensitivity** – Yes

12-Newhaven Proposed Option

- **Mounting Strategy:** Ground-mounted
- **Location:** Within Newhaven Primary school grounds. Proximity to LV substation ~80m
- **Proposed connection**: Underground to nearest distribution pole, then overhead to LV substation. Final connection strategy to be determined during detailed design.
- **Pros:** Minimal vegetation clearance required. Location does not fall within any planning overlays.
- **Cons**: Land would need to be acquired from Newhaven Primary School. Additional safety measures around the battery site may be required, which may result in increased costs.

Figure 14: 12-Newhaven Proposed Option – Ground Mounted LV Neighbourhood Battery and Figure 15: 12-Newhaven Proposed Option – Street View provide a high-level overview of the proposed battery location for 12 - Newhaven. The blue pointer denotes the existing LV substation, and the yellow polygon denotes the estimated battery location.

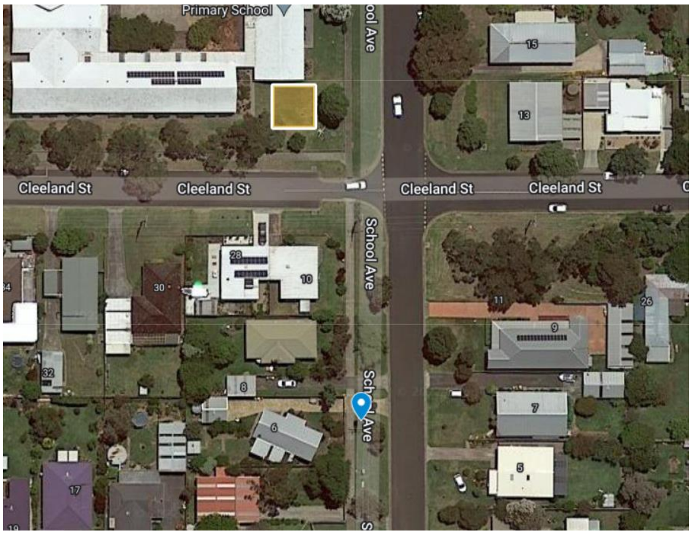

Figure 14: 12-Newhaven Proposed Option – Ground mounted LV Neighbourhood Battery

Figure 15: 12-Newhaven Proposed Option – Street view

12-Newhaven Alternative Option

- **Mounting Strategy:** Pole-mounted
- **Location:** Pole adjacent to the existing LV substation pole (south) – proximity from the pole to LV substation is approximately ~40m
- **Proposed connection**: Overhead
- **Pros:** No land or vegetation clearance is expected to be required for the installation and operation of the battery.
- **Cons**: The battery would need to be undersized to be pole mounted. Location is within a bushfire prone area, which triggers additional CFA requirements. Location falls within multiple planning overlays.

Figure 16: 12-Newhaven Alternative Option – Pole-top LV Neighbourhood Battery and Figure 17: 12-Newhaven Alternative Option – Street View provide a high-level overview of the alternative battery location for 12 - Newhaven. The blue pointer denotes the existing LV substation, and the yellow pointer denotes the potential pole for the pole-top LV Neighbourhood Battery.

Figure 16: 12-Newhaven Alternative Option – Pole-top LV Neighbourhood Battery

Figure 17: 12- Newhaven Alternative Option – Street view

3-Cape Woolamai LV Substation

3-Cape Woolamai Site Constraints / Considerations

- **Planning overlay:** Vegetation protection overlay – Schedule 2 (VPO2) – only applicable for "Alternative Option"
- **Bushfire prone area:** No
- **Zoning**
  . General residential zone or Mixed-Use Zone – Schedule 1 (GRZ1)
  . Public Use Zone– Education (PUZ2)
- **Aboriginal Cultural Heritage Sensitivity** – No

3-Cape Woolamai Proposed Option

- **Mounting Strategy:** Ground-mounted
- **Location:** Potentially between Burnt Toast café and Vista Dr. Proximity to LV substation is approximately ~150m.
- **Proposed connection**: Underground to nearest distribution pole, then overhead to LV substation. Final connection strategy to be determined during detailed design.
- **Pros:** Minimal vegetation clearance required. Location does not appear to be currently in use by any entities.

- **Cons**: Relatively long distance to existing LV substation, resulting in increased cabling costs.

Figure 18: 3-Cape Woolamai Proposed Option – Ground-mounted LV Neighbourhood Battery and Figure 19: 3- Cape Woolamai proposed Option – Street View provide a high-level overview of the proposed battery location for 3 - Cape Woolamai. The blue pointer denotes the existing LV substation, and the yellow polygon denotes the estimated battery location.

Figure 18: 3-Cape Woolamai Proposed Option - Ground-mounted LV Neighbourhood Battery

Figure 19: 3-Cape Woolamai Proposed Option – Street view

3-Cape Woolamai Alternative Option

- **Mounting Strategy:** Ground-mounted
- **Location:** Adjacent to existing LV substation within the nature reserve. Proximity to LV substation is approximately ~5m.
- **Proposed connection**: Overhead
- **Pros:** Minimal vegetation clearance required to accommodate the installation and operation of the battery. Immediate proximity to existing LV substation resulting in reduced cabling costs.
- **Cons**: Location is in close proximity to residential housing. Final battery footprint is not confirmed, and therefore available land in this location may not be sufficient to meet all clearance requirements.

Figure 20: 3-Cape Woolamai Alternative Option – Ground-mounted LV Neighbourhood Battery and Figure 21: 3-Cape Woolamai Alternative Option – Street View provide a high-level

overview of the proposed battery location for 3 - Cape Woolamai. The blue pointer denotes the existing LV substation, and the yellow polygon denotes the estimated battery location.

Figure 20: 3-Cape Woolamai Alternative Option - Ground-mounted LV Neighbourhood Battery

Figure 21: 3-Cape Woolamai Alternative Option - Street view

8–Cape Woolamai LV Substation

8-Cape Woolamai Site Constraints / Considerations

- **Planning overlay:**
  . General residential zone – Schedule 1 (GRZ1)
  . Vegetation protection overlay – Schedule 2 (VPO2)
- **Bushfire prone area:** No
- **Zoning** Public Park and Recreation Zone (PPRZ)
- **Aboriginal Cultural Heritage Sensitivity**: No

8-Cape Woolamai Proposed Option

- **Mounting Strategy:** Pole-Mount
- **Location:** Pole adjacent to the existing LV substation pole (north). Distance approximately ~40m
- **Proposed connection**: Overhead
- **Pros:** No major land or vegetation clearance is expected to be required for the installation and operation of the battery.

- **Cons**: The size of the battery is limited to the maximum size of available pole-mounted batteries, which limits the opportunity for future expansion.

Figure 22: 8-Cape Woolamai Proposed Option – Pole-top LV Neighbourhood Battery and Figure 23: 8-Cape Woolamai Proposed Option - Street View provide a high-level overview of the proposed battery location for 8 - Cape Woolamai. The blue pointer denotes the existing LV substation, and the yellow pointer denotes the potential pole for the pole-top LV Neighbourhood Battery.

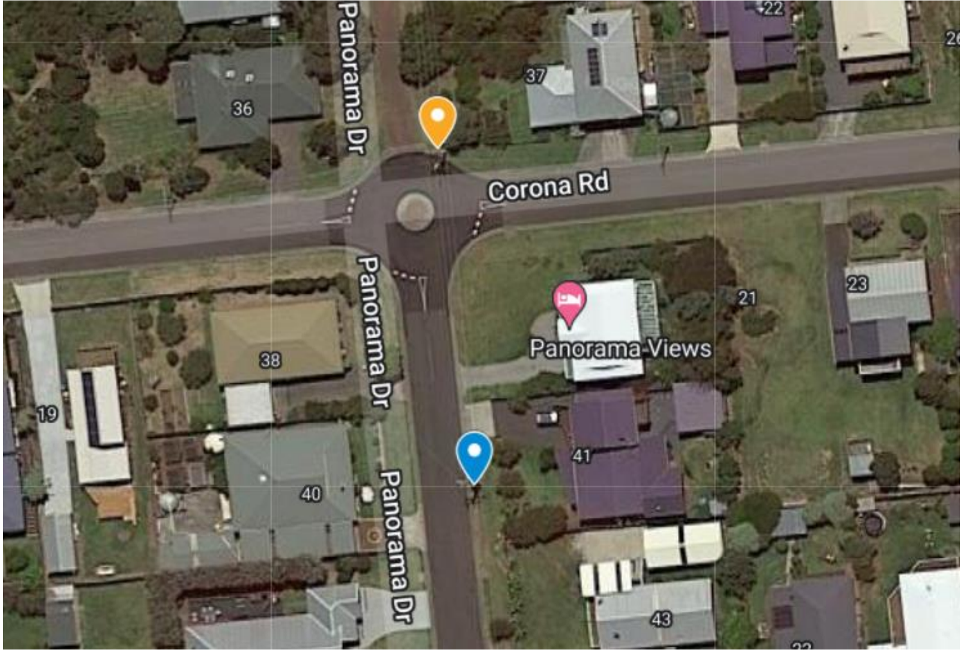

Figure 22: 8-Cape Woolamai Proposed Option – Pole-top LV Neighbourhood Battery

Figure 23: 8-Cape Woolamai Proposed Option - Street view

8-Cape Woolamai Alternative Option

- **Mounting Strategy:** Ground-mounted
- **Location:** at the Woolamai Park Playground - proximity to existing LV substation is approximately ~150m.
- **Proposed connection**: Underground
- **Pros:** Minimal vegetation clearance required for the footprint of the battery. No size limitations on LV Neighbourhood Battery, allowing for future expansion if required.
- **Cons**: Significant vegetation clearance required for an underground connection to the LV substation. Relatively long distance to existing LV substation. This is expected to incur additional costs associated with underground cable reticulation (trenching, conduits, cabling, etc)

Figure 24: 8-Cape Woolamai Alternative Option – Ground Mounted LV Neighbourhood Battery and Figure 25: 8-Cape Woolamai Alternative Option – Street View provide a high-level overview of the proposed battery location for 8 - Cape Woolamai. The blue pointer denotes the existing LV substation, and the yellow polygon denotes the estimated battery location.

Figure 24: 8-Cape Woolamai Alternative Option - Ground-mounted LV Neighbourhood Battery

Figure 25: 8-Cape Woolamai Alternative Option - Street view

32–Cowes LV Substation

32-Cowes Site Constraints / Considerations

- **Planning overlay:** Design and development overlay (DDO)
- **Bushfire prone area:** No
- **Zoning:** Public use – Local government
- **Aboriginal Cultural Heritage Sensitivity**: No

32-Cowes Proposed Option

- **Mounting Strategy:** Pole-Mount
- **Location:** Pole adjacent to the existing LV substation pole (east). Distance approximately ~40m.
- **Proposed connection**: Overhead
- **Pros:** No major land or vegetation clearance is expected to be required for the installation and operation of the battery.
- **Cons**: The size of the battery is limited to the maximum size of available pole-mounted batteries, which limits the opportunity for future expansion.

Figure 26: 32-Cowes Proposed Option – Pole-top LV Neighbourhood Battery and Figure 27: 32-Cowes Proposed Option – Street View provide a high-level overview of the proposed battery location for 32 - Cowes. The blue pointer denotes the existing LV substation, and the red pointer denotes the potential pole for the pole-top LV Neighbourhood Battery.

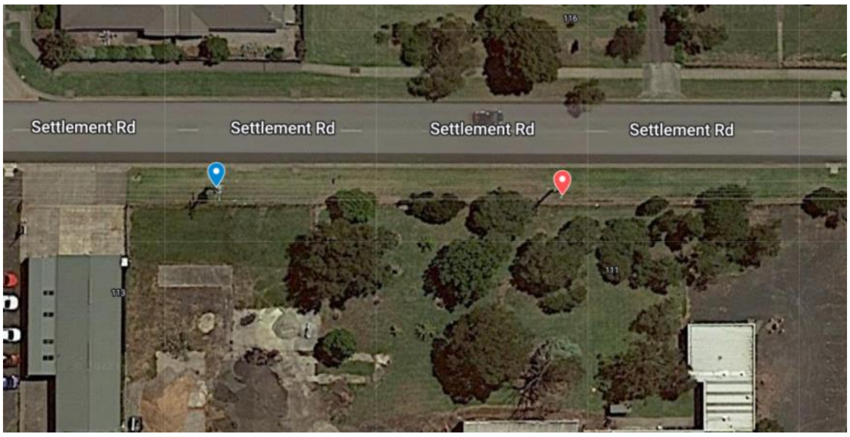

Figure 26: 32-Cowes Proposed Option – Pole-top LV Neighbourhood Battery

Figure 27: 32-Cowes Proposed Option – Street view

32-Cowes Alternative Option

- **Mounting Strategy:** Ground-mounted
- **Location:** within the Phillip Island Fire Station land (south of the LV substation). Proximity to existing LV substation is approximately ~10m.
- **Proposed connection**: Underground
- **Pros:** Minimal vegetation clearance required for the footprint of the battery. No size limitations on LV Neighbourhood Battery, allowing for future expansion if required. . Relatively close in proximity to existing LV substation, resulting in reduced costs related to cabling
- **Cons**: Land would need to be acquired from Phillip Island Fire Station. Vegetation clearance may be required to allow for an underground connection to the LV substation. This is expected to incur additional costs associated with underground cable reticulation (trenching, conduits, cabling, etc).

Figure 28: 32-Cowes Alternative Option – Ground Mounted LV Neighbourhood Battery and Figure 29: 32-Cowes Alternative Option – Street View provide a high-level overview of the proposed battery location for Cowes (32). The blue pointer denotes the existing LV substation, and the yellow polygon denotes the estimated battery location.

Figure 28: 32-Cowes Alternative Option – Ground-mounted LV Neighbourhood Battery

Figure 29: 32-Cowes Alternative option – Street view

37–Cowes LV Substation

37-Cowes Site Constraints / Considerations

- **Planning overlay:** None
- **Bushfire prone area:** Yes
- **Zoning**
  . Farming zone – applicable to "Proposed Option" only
  . TRZ2 – Transport Zone - applicable to "Alternative Option" only
- **Aboriginal Cultural Heritage Sensitivity** – No

37-Cowes Proposed Option

- **Mounting Strategy:** Ground-mounted
- **Location:** on the farming land south from the existing LV substation. Proximity to LV substation is approximately ~20m.
- **Proposed connection**: Underground
- **Pros:** Minimal vegetation clearance required for the footprint of the battery. No size limitations on LV Neighbourhood Battery, allowing for future expansion if required.
- **Cons**: Vegetation clearance may be required to allow for an underground connection to the LV substation. This is expected to incur additional costs associated with underground cable reticulation (trenching, conduits, cabling, etc)

Figure 30: 37-Cowes Proposed Option – Ground Mounted LV Neighbourhood Battery provides a high-level overview of the proposed battery location for 37 – Cowes. The blue pointer denotes the existing LV substation, and the yellow polygon denotes the estimated maximum battery footprint of 10x10m. The final footprint is to be determined with the final LV Neighbourhood Battery sizing and 10m fire break area inclusion as per CFA guidelines.

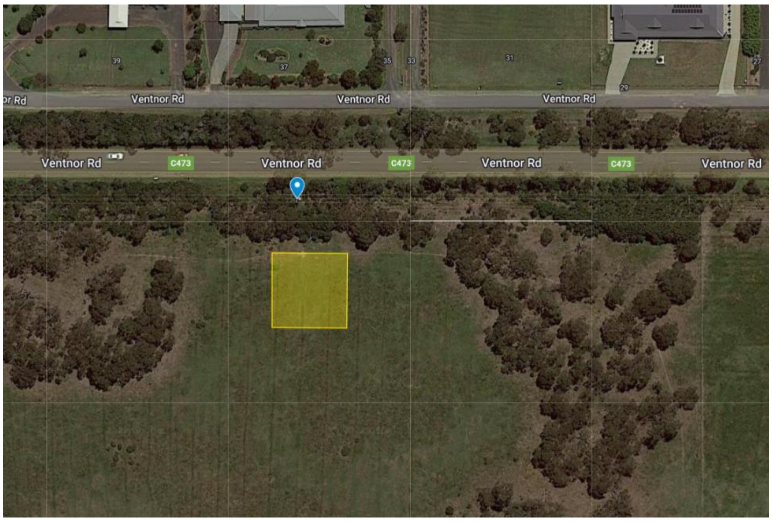

Figure 30: 37-Cowes Proposed Option – Ground-mounted LV Neighbourhood Battery

37-Cowes Alternative Option

- **Mounting Strategy:** Pole-mounted
- **Location:** Pole adjacent to the existing LV substation pole (east) – proximity from the pole to LV substation is approximately ~90m
- **Proposed connection**: Overhead
- **Pros:** No land or vegetation clearance is expected to be required for the installation and operation of the battery.

- **Cons**: The battery would need to be undersized to be pole mounted.

Figure 31: 37-Cowes Alternative Option – Pole-top LV Neighbourhood Battery and Figure 32: 37-Cowes Alternative Option – Street View provide a high-level overview of the alternative battery location for 37-Cowes. The blue pointer denotes the existing LV substation, and the red pointer denotes the potential pole for the pole-top LV Neighbourhood Battery.

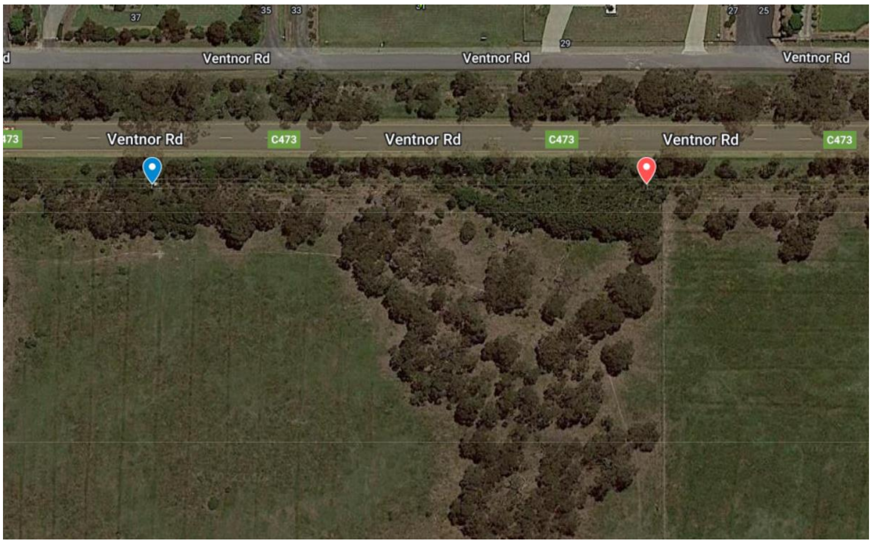

Figure 31: 37-Cowes Alternative Option - Pole-top LV Neighbourhood Battery

Figure 32: 37-Cowes Alternative Option – Street view

12–Cowes LV Substation

12-Cowes Site Constraints / Considerations

- **Planning overlay:** Design and development overlay (DDO) – applicable to "Alternative Option" only
- **Bushfire prone area:** Yes

- **Zoning**
  . TRZ3 – Transport Zone, significant municipal road. Applicable to “Proposed Option” only.
  . Farming zone – applicable to “Alternative Option” only.
- **Aboriginal Cultural Heritage Sensitivity** – Yes

12-Cowes Proposed Option

- **Mounting Strategy:** Pole-Mount
- **Location:** Pole adjacent to the existing LV substation pole (west). Distance approximately ~50m.
- **Proposed connection**: Overhead
- **Pros:** No major land or vegetation clearance is expected to be required for the installation and operation of the battery.
- **Cons**: The size of the battery is limited to the maximum size of available pole-mounted batteries, which limits the opportunity for future expansion.

Figure 33: 12-Cowes Proposed Option – Pole-top LV Neighbourhood Battery and Figure 34: 12-Cowes Proposed Option – Street View provide a high-level overview of the proposed battery location for 12-Cowes. The blue pointer denotes the existing LV substation, and the red pointer denotes the potential pole for the pole-top LV Neighbourhood Battery.

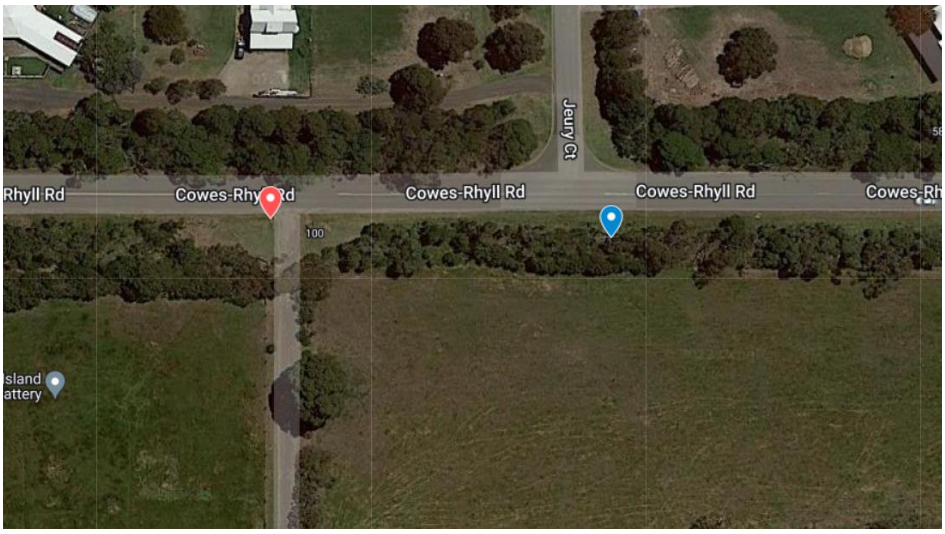

Figure 33: 12-Cowes Proposed Option - Pole-top LV Neighbourhood Battery

Figure 34: 12-Cowes Proposed Option – Street view

12-Cowes Alternative Option

- **Mounting Strategy:** Ground-mounted
- **Location:** Within the farming land south of the existing LV substation - proximity to LV substation is ~20m.
- **Proposed connection:** Underground
- **Pros:** Minimal vegetation clearance required for the footprint of the battery. No size limitations on LV Neighbourhood Battery, allowing for future expansion if required . Relatively close in proximity to existing LV substation, resulting in reduced costs related to cabling
- **Cons:** Vegetation clearance may be required to allow for an underground connection to the LV substation. This is expected to incur additional costs associated with underground cable reticulation (trenching, conduits, cabling, etc)

Figure 35: 12-Cowes Alternative Option – Ground Mounted LV Neighbourhood Battery provides a high-level overview of the alternative battery location for 12 - Cowes. The blue pointer denotes the existing LV substation, and the yellow polygon denotes the estimated maximum battery footprint of 10x10m. The final footprint is to be determined with the final LV Neighbourhood Battery sizing and 10m fire break area inclusion as per CFA guidelines.

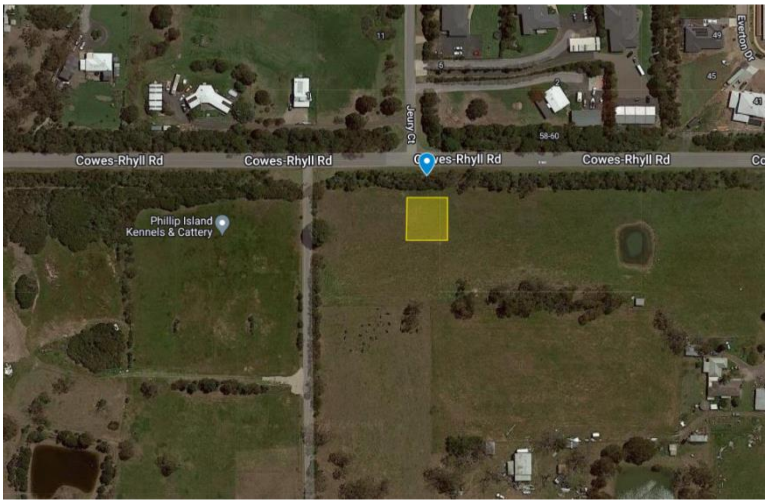

Figure 35: 12-Cowes Alternative Option – Ground-mounted LV Neighbourhood Battery

39-Cowes LV Substation

39-Cowes Site Constraints / Considerations

- **Planning overlay:**
  . Design and development overlay (DDO) – applicable to "Proposed Option" only.
  . Vegetation protection overlay – Schedule 2 (VPO2) - applicable to "Alternative Option" only.
- **Bushfire prone area:** No
- **Zoning**
  . Public Park and recreation zone (PPRZ) - applicable to "Proposed Option" only.
  . General residential zone – Schedule 1 (GRZ1) - applicable to "Alternative Option" only.
- **Aboriginal Cultural Heritage Sensitivity** – No

39-Cowes Proposed Option

- **Mounting Strategy:** Ground-mounted
  - **Location:** within the Blue Gum Reserve (west of the LV substation) - proximity to LV substation is approximately ~70m.
- **Proposed connection**: Underground
- **Pros:** Minimal vegetation clearance required for the footprint of the battery. No size limitations on LV Neighbourhood Battery, allowing for future expansion if required.
- **Cons**: Vegetation clearance may be required to allow for an underground connection to the LV substation. This is expected to incur additional costs associated with underground cable reticulation (trenching, conduits, cabling, etc)

Figure 36: 12-Cowes Proposed Option – Ground-mounted LV Neighbourhood Battery provides a high-level overview of the alternative battery location for 12 - Cowes. The blue pointer denotes the existing LV substation, and the yellow polygon denotes the estimated battery location.

Figure 36: 12-Cowes Proposed Option – Ground-mounted LV Neighbourhood Battery

12-Cowes Alternative Option

- **Mounting Strategy:** Pole-mounted
- **Location:** Pole adjacent to the existing LV substation pole (south) – proximity from the pole to LV substation is approximately ~50m
- **Proposed connection**: Overhead
- **Pros:** No land or vegetation clearance is expected to be required for the installation and operation of the battery.
- **Cons**: The battery would need to be undersized to be pole mounted.

Figure 37: 12-Cowes Alternative Option – Pole-top LV Neighbourhood Battery and Figure 38: 12-Cowes Alternative option – Street View provide a high-level overview of the proposed battery location for 12 - Cowes. The blue pointer denotes the existing LV substation, and the yellow pointer denotes the potential pole for the pole-top LV Neighbourhood Battery.

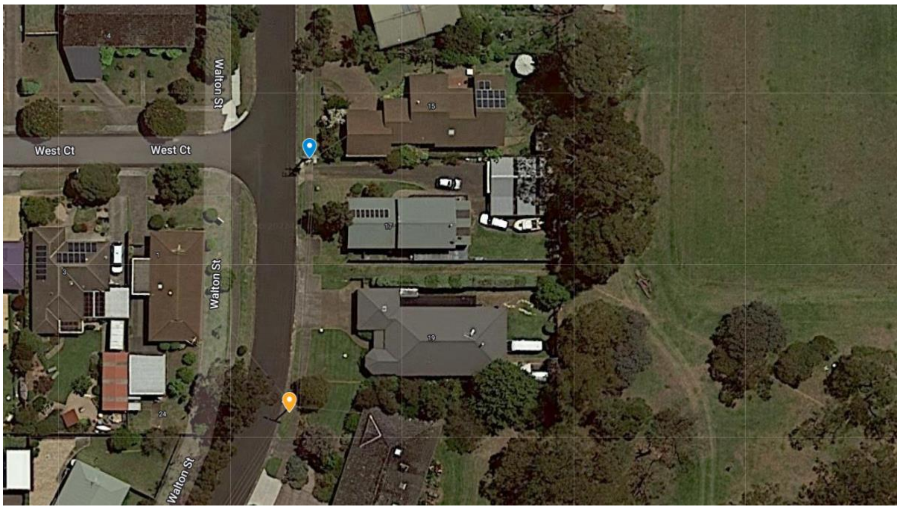

Figure 37: 12-Cowes Alternative Option - Pole-top LV Neighbourhood Battery

Figure 38: 12-Cowes Alternative Option - Street view

5.4 Grid Connection Requirements

5.4.1 Grid Connection Applications and Approval

As part of the LV battery storage system Distribution Network Service Provider (DNSP) grid connection approval, the following documents are required to be submitted to begin the process:

- LV battery storage system DNSP pre-approval
- Single line diagram of the LV battery storage system

The timeframe for approvals to the DNSP is up to three months and the typical costs for application submissions are between $2000 and $3500.

Each battery will require its own connection application as the battery connection requirements and existing network infrastructure will vary from site to site.

5.4.2 Grid Connection Fees

Once the connection application has been submitted, reviewed, and approved by the DNSP, an offer will be presented by the DNSP to outline the fees associated with the new connection. These costs will vary between sites as they are dependent on each site’s specific infrastructure and proposed battery requirements.

Ultimately, the complexity of the works associated with individual battery connection will determine the fees payable to the DNSP.

5.4.3 Approximate Connection Timelines and Processes

There are four stages between the initial design of a LV battery storage system and the completed LV battery storage system being connected to the grid.

1. Design of LV battery storage system and pre-approval DNSP application for LV battery storage system installation. (~ three months)
2. Installation of the LV battery storage system and execution of commissioning tests. (Depending on battery lead time).
   - The LV battery storage system installation shall start after receiving DNSP pre-approval.
   - A commissioning test report must be produced after the commissioning tests have been performed.
3. Submission of paperwork to DNSP for approval to connect the LV battery storage system to the grid. (~two weeks).
   - The final connection is subject to:
     . Final connection agreement between DNSP and the LV battery storage system’s owner
     . Technical schedules
     . The electrical installation must have passed the specified inspection
     . Valid certificate of electrical safety (CES)
     . Compliance with AS 4777 for the electrical installation
     . Compliance with AusNet Services’ commissioning test requirements
     . A copy of the commissioning test report, including the valid CES and any other relevant tests requested.
4. Ready to switch on. (~two weeks)
   - The following documents must be supplied to DNSP prior to final connection:
     . Completed electrical works request (EWR)
     . Completed Certificate of Electrical Safety (CES).

5.5 Battery Technology Comparison

5.5.1 Na-ion / Li-ion Comparison

5.5.1.1 Summary

Na-ion batteries will have a distinct advantage over lithium batteries in situations where the size and weight of the batteries are not strictly bounded, i.e., grid storage batteries. It constitutes sustainable lower-cost alternatives due to the abundant nature of sodium when compared to lithium. Another major advantage of sodium over lithium technology is in sustainability and supply chain, e.g., Na-ion batteries do not require cobalt, which is a highly sought mineral used in Li-ion batteries. There is a current shortage of Cobalt with the growth of the electric vehicle (EV) market.[2]

5.5.1.2 Performance

Energy Density

	Energy Density (Wh/kg)	**Energy Density (Wh/l)**
Na-Ion	100 – 150	250-375
Li-ion	126 – 285	340-530

Table 6: Energy Density Comparison

- Li-ion are more energy dense, i.e., are lighter and less volume (more compact)
- Na-ion possess good rate capability, generating power with less voltage loss when compared to Li-ion
- NA-ion are suitable for applications including ESS (Energy Storage System) and other applications where energy density requirements are less demanding
- Na-ion batteries can replace battery chemistry technologies such as LiFePO4, Pb-acid, Ni/Cd, and Ni/MH

5.5.1.3 Cost

Na-ion batteries are predicted to be about 10-20% cheaper than Li-ion batteries by 2025 [3]

5.5.1.4 Availability

Only a few major battery manufacturers are currently investing in a supply chain for Na-ion batteries. This supply chain is not yet set up and the batteries are not yet available in commercial quantities in Australia. However, in the long run, Na-ion batteries have a distinct advantage over Li-ion batteries in that sodium is more abundant and easier to source than lithium.

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[2] https://www.bloomberg.com/news/features/2021-09-23/future-of-energy-requires-cleaner-electric-batteries-to-solve-cobalt-problem

[3] How Comparable Are Sodium-Ion Batteries to Lithium-Ion Counterparts? - https://pubs.acs.org/doi/pdf/10.1021/acsenergylett.0c02181

5.6 Options for Remote Orchestration

Distributed Energy Resources (DERs) are small power sources and flexible loads which when combined, can help balance supply and demand. In this case, they are the LV Neighbourhood batteries.

Remote Orchestration is the process of managing downstream assets (DERs) to provide services including energy, network, and system security services (for example frequency control) and flexible operation modes, in addition to meeting the needs of the DER owner.

5.6.1 Mondo Platform

The Mondo platform (powered by the Ubi Energy Management Platform) includes an Internet of Things (IoT) device (Ubi device) with edge computing capability, cloud data store, customer portal and control for monitoring and managing fleets of DER assets.

5.6.1.1 Ubi Device

The Ubi device is an edge device that can connect to and obtain data from connected solar and battery inverters, as well as monitoring of sub-circuits using installed current transformers (CTs). The device also has local compute capability built-in, allowing for implementation of optimisation logic without the need for an Internet connection or other communications. This includes local optimisation such as discharging of customer batteries to achieve a desired demand threshold, voltage support through exporting of reactive power, limiting of export or directing excess solar to controllable loads, and the ability to execute pre-loaded schedules to suit requirements.

5.6.1.2 Ubi Energy Management Platform

When Ubi is paired with the Energy Management Platform, the Ubi forms part of a microgrid orchestration solution that can provide many benefits, including the optimisation of DER assets as well as detailed monitoring and logging of DER asset operation. The orchestration platform can deliver customer and network value through features such as demand peak lopping, battery charge optimisation, voltage support and an overall maximisation of self-consumption of generated energy for the customer. The platform has an extensive API (Application Programming Interface) to allow the sharing of data between the platform and other platforms, such as other Third-Party microgrid solutions and DNSP-specific platforms.

The ability for the platform to take measurement data from select assets from a DNSP Supervisory Control and Data Acquisition (SCADA) system is in development but will provide a powerful integration for the platform to have increased visibility of the upstream network.

5.6.1.3 Benefits and opportunities for using this solution

The tight integration between the end device and platform, an intuitive operational control centre and customer portal, as well as the development of a DNSP-focused platform integration means that the microgrid solution provided by the Ubi Energy Management Platform will be advantageous for the proposed solution for the community.

5.7 Design Requirements

Battery installation must comply with the Electrical Safety Act 1998, as well as the following regulations:

- AS/NZS 3000 Wiring Rules

- AS/NZS 5139:2019 Electrical Safety (General) Regulations
- AS/NZS 4771.1:2016 Inverter Installation

Battery product standards must comply with Best Practice Guide: Battery Storage Equipment – Electrical Safety Requirements (2018)[4]. Energy Safe Victoria oversees regulation of battery installation and is providing support and guidance to current project proponents.

Battery Design should also follow Country Fire Authority – *Design Guidelines and Model Requirements for Renewable Energy Facilities*[5].

There have been recent amendments to Clause 73.03 Land use terms of the Victoria Planning Provisions (VPP)[6] to enable all planning schemes in Victoria to support the delivery of neighbourhood batteries into the electricity distribution network. If the battery meets the definition of a minor utility installation as set out in the Clause 73.03, it is exempt from requiring a planning permit in all zones and overlays except the Public Conservation and Resource Zone.

5.8 Future Design Considerations

5.8.1 LV Battery design requirements

5.8.1.1 Enclosure Requirements

The minimum unimpeded access on any working side of the LV battery storage system enclosure in ground-mounted and pole-mounted setting as specified by the Australian standards (AS 62619) needs to be either:

- 900mm with doors open or
- Clearance specified by the manufacturer

The Clean Energy Council (CEC) recommends IP54 rating for the enclosure. This rating means that it is protected against dust limited ingress and protected against water splashed from all directions. This ensures protection from wildlife and the elements (i.e., wind, rain etc.). The platform and enclosure are recommended to be constructed of aluminium, steel or equivalent material to minimise the risk of fire.

The IP rating of manufacturers enclosures is checked against the relative standards and required site conditions (i.e., native wildlife, temperature ranges, UV exposure etc.)

5.8.1.2 Noise limits

Noise limitations will depend on the site and surrounding areas. The requirements for noise limits are outlined in the Victorian EPA's 1412: SEPP N-1 document[7]. As these limits are site dependant, a detailed desktop review will be conducted in the next stages of the detailed technical design part of the feasibility study.

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[4] https://batterysafetyguide.com.au/
[5] https://www.cfa.vic.gov.au/plan-prepare/building-planning-regulations/renewable-energy-fire-safety
[6] https://planning-schemes.app.planning.vic.gov.au/Victoria%20Planning%20Provisions/amendments/VC220
[7] https://www.epa.vic.gov.au/about-epa/publications/1412

5.8.1.3 Proximity to the grid

With regards to proximity to the grid, pole-top LV Neighbourhood batteries are ideally suited as they are usually in close proximity to the asset they are connecting to. This greatly simplifies selection of suitable sites for the installation of the LV battery.

Ground-mounted LV Neighbourhood batteries are more difficult (relative to pole-top LV batteries) to locate because both proximity to poles/grid and suitable site footprint are required. The further the ground-mounted LV battery is from the poles/grid, the more excavation for LV power distribution needs to be considered if the connection is via underground cable. This creates an extra factor to be considered when positioning ground-mounted LV Neighbourhood batteries. The connection may be achieved via overhead cabling, which is a simpler and cheaper solution, however it will depend on the site-specific conditions and surroundings.

5.8.1.4 Vegetation Clearance

Pole-top LV Neighbourhood batteries require relatively little, if any, vegetation clearance, as the batteries are located along assets that already have vegetation maintenance requirements maintained by the DNSP.

Ground-mounted LV Neighbourhood batteries may require extensive vegetation clearance depending on the condition of the selected site. Vegetation will need to be cleared to maintain a safe working environment around the batteries as outlined in Vegetation (i.e. 900mm surrounding the enclosure). Further vegetation clearances may be required if the battery is located away from the LV distribution network assets and underground wires are required to connect to the LV network.

5.8.1.5 Wildlife protection

Wildlife will be protected from electrical hazards for both pole-top and ground-mounted LV battery storage systems via the physical barrier of the enclosure and fencing. Wildlife Protection outlines, a suitably IP rated enclosure will prevent the vast majority of wildlife and vermin access to equipment. Further wildlife protection measures are covered by the general safety measures outlined in the following section.

5.8.1.6 Safety Measures

Manufacturers and designers are required to comply with a variety of Australian Standards for LV battery and other electrical installations.

Safety measures are included in both the design and manufacture of the LV battery storage systems. For ground-mounted LV battery storage systems design, depending on the site location, additional mechanical barriers such as bollards, to prevent damage from vehicles and fencing to prevent intrusion and protect the wildlife by restricting access may be considered. Similarly, manufacturers will consider safety when designing the LV battery storage system, by using suitably rated enclosures to avoid electrical and other hazards. Other measures are also considered such as:

- Thermal management systems to minimise fire risks and prolong battery life
- Battery management systems and suitably rated electrical protection equipment to further manage electrical hazards and fire risks

6. Commercial Analysis

6.1 Ownership Structures

6.1.1 Community Owned

Under this ownership structure, the community would own the batteries outright. It is recommended that a retailer be engaged to provide a route to market, renewable generation exposure and customer management. This will assist to minimise the exposure of risk to the community. As the owner, the community has direct input in how the batteries should operate.

Within this ownership structure, 'direct equity' and debt are the key means of funding the asset. Under the direct equity funding arrangement, members of the community would contribute funds and thereby become shareholders in the batteries. Alternatively, the community could loan the funds to a community-run holding company where the holding company owns the asset (e.g., the community members do not) and is liable to repay any loan(s) to the community at a point in the future.

Company structures applicable to community ownership would include 'for' and 'not-for' profit, co-operatives (e.g., several community organisations), public and private companies. An example of a community ownership model is the Yackandandah community battery program – refer to Appendix B for more information.

6.1.2 Third-Party Owned

Under this ownership structure, a third party would own and operate the batteries. Possible Third-Party owners are outlined in Figure 39: Third Party Owned Potential Structures below. During the project development, construction, and operations, the community will be a key stakeholder providing input into the batteries, but otherwise by default are not involved in the day-to-day operations (except passively experiencing its benefits) unless an agreement is in place.

An example of a Third-Party ownership model is United Energy's "Electric Avenue" project – refer to United Energy "Electric Avenue" for more information.

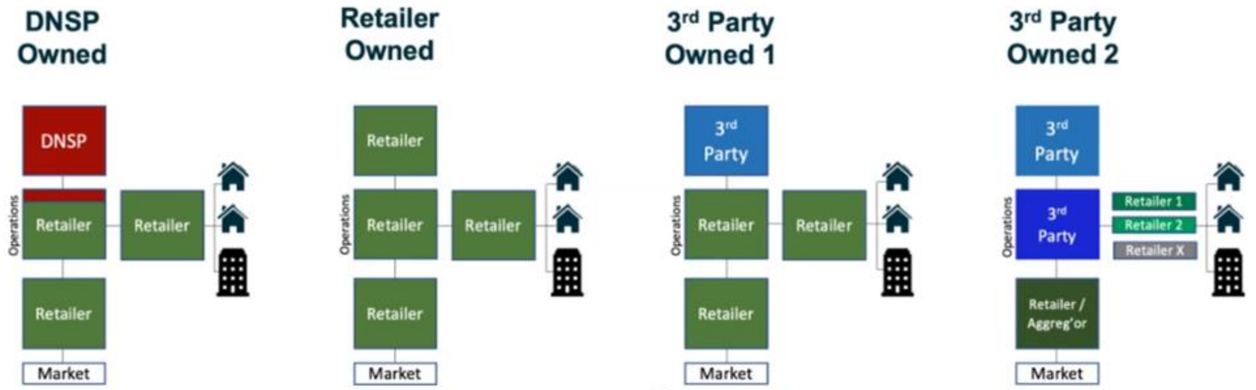

Figure 39: Third-Party Owned Potential Structures

6.1.3 Joint Venture

Under this ownership structure, the batteries would be partly owned by the community and partly owned by a third party. This approach is generally not recommended because it exposes the community to unnecessary technical and commercial risk. This option also raises potential competing interests between the community and the Third-Party owner.

6.1.4 Challenges and Benefits

The table below provides a summary of the various challenges and benefits associated with the specific ownership structures outlined in this report.

Ownership structure	Benefits	Challenges/risks
Community owned	• More say in the operation of the batteries • Community can directly benefit from revenue generated by battery operations • -Reliability can be better guaranteed	• Exposed to commercial/market risks • Requires high capital contribution • Ownership responsibilities (operations, maintenance, etc.)
Third-Party Owned	• Community is exposed to less risk and still benefits from any reliability improvements system is set up to provide • Third party is responsible for owning, operating, and maintaining the batteries	• Getting operational changes proposed/implemented • Potentially less input into System design and operation • A Third-Party will have expectations of a return on investment
Joint Venture	• Community is exposed to less risk than sole ownership	• Competing interests • Can be a difficult relationship to manage • Community is still exposed to risk owning the asset • JV partner will have expectations of a return on investment

Table 7: Ownership structures, benefits, and challenges

6.2 Operational Models

The operational model is highly dependent on the final ownership model decided upon by the community. The operational model will determine how the batteries will deliver value to the community and the asset owners.

If the batteries are Third-Party owned, then operations will be a decision for the Third-Party operator and the community would experience passive benefits, such as a reduction in solar curtailment by acting as a solar sponge.

If the batteries are owned by the community, then a retailer would need to be engaged to coordinate an operating model.

Possible examples of operation structures include:

- Waiving the network tariff and operating the batteries to the benefit of the network and distributor. United Energy are taking this approach through their pole top battery program (See appendix B for details). United Energy has proposed to waive the network tariff for grid batteries that will be operated to the net benefit of the network or that are owned by the distributor.
- Operating the batteries as part of a virtual power plant (VPP).

6.3 Potential Grid Services and Market Revenues

A number of potential grid services as part of the proposed solution have been identified through the commercial analysis process. These are:

- Peak shaving
- Solar soaking
- Voltage support
- Wholesale energy sales
- Frequency support

There are potential market revenues associated with these grid services, which are direct financial benefits for the owner(s) of the storage system.

Additionally, deployment of the storage assets may result in deferred network augmentation for the DNSP. This may result in a payment to the asset owner derived from a portion of the deferral value.

6.3.1 Estimation

Whilst it is difficult to quantify the value of peak shaving, solar soaking and voltage support (as these would be governed by network support agreements), frequency support and energy are given a spot price by the wholesale energy market in a similar fashion to commodities.

Within the National Electricity Market (NEM), energy is sold directly, and the frequency support market is referred to as Frequency Control and Ancillary Services (FCAS), which consists of eight sub-markets for these services.

Mondo has access to price forecasts for FCAS and energy, which have been used to estimate the respective values associated with the proposed LV battery solution (as an aggregated fleet). The estimated values are as per below:

- Energy: $20-$30k p.a. (for total fleet)
- FCAS: $5-$15k p.a. (for total fleet)

Finally, the value of deferred network augmentation is estimated to be around 3% p.a[8]. of the network augmentation cost. For the purpose of this analysis, this cost has been estimated to be within the range of $200k to $1m for each megawatt of capacity that needs to be added as a result of excess consumption or additional solar enablement works at the substation level.

6.4 Financial Modelling

6.4.1 Capital Costs or Expenditure (CAPEX)

The table below provides an overview of the estimated CAPEX range for each of the proposed sites. These costs are highly indicative and are not contractual in nature.

Substation	Estimated Capex ($) m=$1,000,000	±50% ($) m=$1,000,000	($/kWh) k=$1,000
30 – Rhyll	0.302m	0.151m – 0.453m	~2.4k
4 – Smiths Beach	0.156m	0.78m – 0.234m	~3.1k
2 – Ventnor	0.184m	0.92m – 0.275m	~2.8k
12 – Newhaven	0.262m	0.131m – 0.393m	~2.5k
3 – Cape Woolamai	0.598m	0.299m – 0.897m	~2.1k
8 – Cape Woolamai	0.160m	0.80m – 0.240m	~3.2k
32 – Cowes	0.160m	0.80m – 0.240m	~3.2k
37 – Cowes	0.253m	0.127m – 0.380m	~2.5k
12 – Cowes	0.124m	0.62m – 0.186m	~4.9k
39 – Cowes	0.365m	0.183m – 0.547m	~2.3k
TOTAL CAPEX	**2.56m**	**1.3m – 3.9m**	-

Table 8 – Capex for individual sites

The costs that form part of the estimated CAPEX figures are:

- Battery Energy Storage System (supply and delivery)
- LV switchboard, including associated cabling (supply and delivery)
- Installation (labour and balance of plant)
- Civil works (relevant to ground-mounted batteries)
- Mounting equipment (relevant to pole-top batteries)
- Mondo Ubi device for battery monitoring and aggregation (supply and delivery)
- Design and Project Management

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[8] The quantum of 3% is based on published 'Regulatory Investment Test for Distribution' (RIT-D) reports, as found on the DNSP websites

- DNSP related fees

The estimated CAPEX costs for this project were found to be in line with KPMG's all-inclusive battery unit costs[9] shown in the figure below.

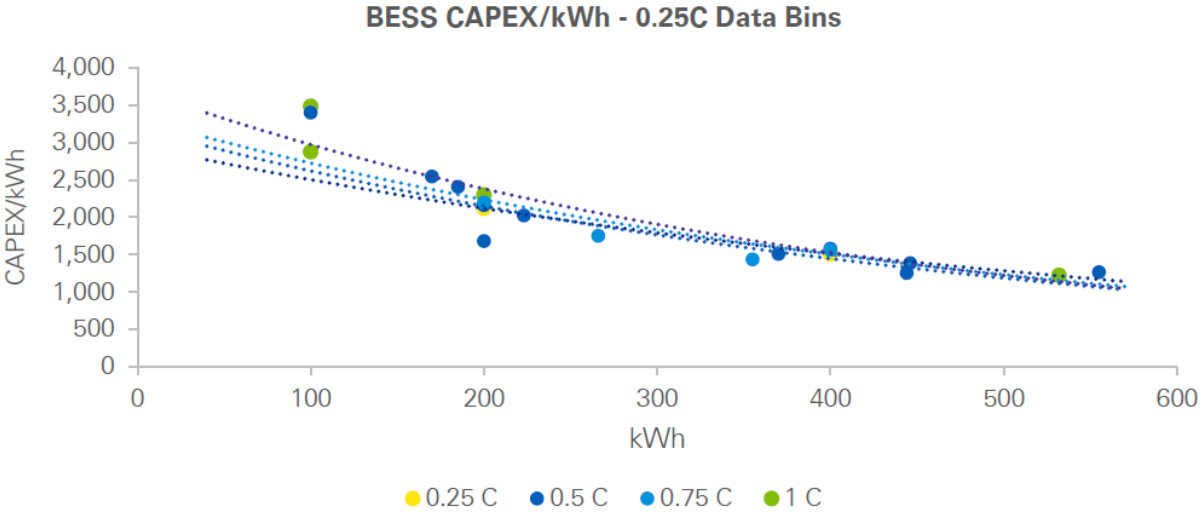

Figure 40: BESS CAPEX/kWh – KPMG Feasibility Report

6.4.2 Operating Costs or Expenditure (OPEX)

OPEX is derived from the manner in which the battery is operated and maintained such as visual inspection, labelling inspection, inspection and testing of electrical connections and cables, inspection of battery condition (cleanliness, state of charge indicator, physical damage, corrosion, level of electrolyte etc.). For the purpose of this feasibility study, the OPEX was assumed to be $4,000 per annum for each of the 10 proposed battery solutions.

6.4.3 Cost Benefit Analysis

A commercial modelling exercise was undertaken as part of the project to estimate and quantify the potential energy and cash flows over the life of the assets (15 years) of the aggregated LV battery solution proposed. Further, this also considers the value stack of the assets (incorporating the likely revenue streams available), where several commercial assumptions were applied to provide several insights.

The ownership structure of the asset does not impact the CAPEX and revenue projections at the aggregate asset level. However, when estimating the project Net Present Values (NPV), the ownership structure does impact that calculation. Therefore, the NPV range presented below assumes two different scenarios:

- **Scenario 1 (worst case):** no government funding and full ownership of the fleet by a third party.

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[9] https://cdn.ausgrid.com.au/-/media/Documents/Reports-and-Research/Battery/Ausgrid-Community-Battery-Feasibility-Study-Report-2020.pdf?rev=abbf2d1303e9428c8a9f7b176a2ffc3c

- **Scenario 2 (best case):** government grant funding is forthcoming, up to a maximum of 49% of the up-front capital cost. Full ownership of the fleet by a third party.

Metric Name	Scenario 1 Results	Scenario 2 Results
Total Estimated CAPEX ($m)	$2.56m	$1.3m (after 49% Gov Funding)
Total Revenue over 15 years ($m)	$0.58m	$0.87m
Project NPV ($m, IRR of 8.65%) *	$3.3m (negative)	$0.47m (negative)

Table 9 – Nett Present Values (NPV) Summary

The NPVs for both Scenario 1 and Scenario 2 were found to be negative, which represents an unfavourable project (from a financial perspective) across the project life (15 years).

6.4.4 Commercial Considerations to Improve the Viability of the Proposed Technical Solution

The three main variables that affect the viability of the proposed LV batteries are CAPEX costs, revenues, and government funding.

In order for the project to return a neutral NPV (no loss or profit made), the following scenarios were analysed at a high level:

- **Reduction of CAPEX costs:** This reduction refers to a decrease in costs of materials, labour, technology, etc. rather than the total size/capacity of the batteries being reduced. Assuming that the revenues from the batteries and the maximum government funding (49%) are fixed, it was found that the total CAPEX cost of the batteries would need to be reduced to approximately $910,000, which represents a 65% reduction.
- **Increase to government funding:** Assuming that the CAPEX and revenues remain fixed, it was found that the government funding would need to increase to 69% from 49%.
- **Increase to revenues:** Assuming that the CAPEX and the maximum government funding (49%) are fixed, it was found that the total revenue across the whole project life (15 years) would need to increase to approximately $1,720,000, which represents a 99% increase. There are a number of revenue streams that are only available under specific circumstances, and are therefore only available to certain types of third-parties. These revenues have been excluded from the commercial analysis as noted in the assumptions section of this report.

6.4.5 Commercial Considerations for Islanding Capabilities

To enable islanding capabilities within LV Neighbourhood batteries, there are multiple factors that must be considered, such as:

- **Grid forming inverters**: This type of inverter allows inverter-based energy sources (such as batteries) to operate independently from the grid.
- **Controller**: This device provides control of the equipment operation (e.g., circuit breaker, ACR, inverter etc.) to enable safe islanding and power supply during outages.
- **Infrastructure costs**: The costs incurred by the DNSP to upgrade the network infrastructure to enable the LV Neighbourhood batteries to island (installation and supply of equipment (e.g., protection devices) to allow successful operation of the islanded LV cluster)

The additional equipment and infrastructure upgrades carry additional costs that must be considered when assessing the feasibility of islanding LV Neighbourhood batteries.

The revised total CAPEX for the entire battery fleet (accounting for islanding capability) is estimated to be $4.8m (~46% CAPEX increase). This increase in CAPEX results in NPVs of $5.75m (negative) and $1.1m (negative) for Scenario 1 and Scenario 2 respectively.

The expected capital investment required to incorporate islanding capabilities into the LV battery solution was found to be disproportional to the expected benefits – therefore, it was found to not be a commercially viable option at this stage.

7. Proposed Technical Solution

The table below highlights the proposed optimal solution at each of the selected sites. The optimal solutions have been determined through the technical and commercial analysis outlined in the relevant sections within this report.

Substation number and area	Pole-top/Ground Mounted	Inverter Size (kW)	Battery Capacity (kWh)[10]	Estimated Land Footprint[11] (m^2)[12]	Battery Can Address		
					excess solar exports	overloading	Islanding[13]
30 – Rhyll	Ground Mounted	40.00	122.54	20	✓	✓	✗
4 – Smiths Beach	Pole-top	15.00	50.12	N/A	✓	✓	✗
2 – Ventnor	Pole-top	16.00	62.65	N/A	✓	✓	✗
12 – Newhaven	Ground Mounted	30.00	103.21	20	✓	✓	✗
3 – Cape Woolamai	Ground Mounted	80.00	278.36	25	✓	✓	✗
8 – Cape Woolamai	Pole-top	25.00	48.34	N/A	✓	✓	✗
32- Cowes	Pole-top	25.00	45.85	N/A	✓	✓	✗
37 – Cowes	Ground Mounted	30.00	99.61	100[14]	✓	✓	✗
12 – Cowes	Pole-top	50.00	22.65	N/A	✓	✓	✗
39- Cowes	Ground Mounted	40.00	157.40	20	✓	✓	✗

Table 10 – Proposed optimal solution for the chosen 10 sites

The proposed optimal solution for the neighbourhood LV Neighbourhood batteries does not provide resilience against power outages as the expected capital investment required to incorporate islanding capabilities into the LV battery solution was found to be disproportional to the expected benefits – therefore, it was found to not be a commercially viable option at this stage. Refer to Technical Analysis and Commercial Analysis of this feasibility report for further details.

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[10] Actual BESS Capacity to be selected in line with products available in the market at the time of detailed design.
[11] Estimated footprint for the total land required for the BESS system, including all clearance requirements
[12] Estimated footprint of Ground-Mounted BESS inclusive of battery cabinet, inverter cabinet and switchboard cabinet, including all clearance requirements
[13] Islanding capability was found to not be a commercially viable option at this stage
[14] Within a bushfire zone, therefore a firebreak zone is required under CFA requirements

8. Assumptions

As part of the feasibility study the following has been assumed:

- Structural integrity of poles can withstand pole-top batteries.
- There are no council permits and licences constraints for the chosen battery installation sites.
- The chosen sites are available for installation of the LV Neighbourhood batteries.
- Pole-top batteries can be installed on DNSP’s assets (poles).
- Additional network augmentation is not required to support installation of the proposed battery solutions.
- There are no grid connection constraints to connect the proposed battery sizes to the grid.
- Pole-top batteries are assumed to be smaller than 75kWh.
- Ground-mounted batteries are assumed to be larger than 75kWh.
- Battery sizes selected are available in the market.
- Asset life of the LV Neighbourhood batteries is assumed to be 15 years.
- Maximum government grant portion to be 49% of total capital cost.
- The Weighted Average Cost of Capital (WACC) rate is assumed to be 8.5%.
- Costing accuracy is assumed to be +/- 50%.
- Grid services revenues are based on consultant forecast.
- There is no derivative revenue assumed for this analysis (e.g., swap or cap contracts).
- NAST12 Distribution Use of System Tariff has been used for the analysis.
- Non-financial benefits have not been assessed as part of the technical and commercial feasibility study as there is no current method to quantify these benefits.

9. Key Project Benefits

9.1 Community / Social

9.1.1 Building Social Capital

Totally Renewable Phillip Island (TRPI) is a voluntary collective of 15 members of local community organisations who have worked tirelessly together with the community and the power sector since inception in 2018 towards a shared vision of carbon neutrality by 2030. TRPI has significant social capital due to its structure and high profile in the community. This project has explored community and neighbourhood batteries as part of the pathway to 100% Renewable Phillip Island.

Totally Renewable Phillip Island can see a future energy system that empowers community to work together to understand and monitor efficient energy usage through local renewable energy production, from household scale through to small utility scale on Phillip Island. This feasibility report is a key component of understanding how local renewable energy can be harnessed, shared, and made accessible at community and household level.

9.1.2 Community Benefit

Phillip Island households at the chosen sites would benefit from improved reliability of supply due to better grid stability and grid strength by installing LV Batteries. The batteries will act as additional generation during peak demand times and additional load during high export times.

With the existing installed solar at the chosen sites the LV batteries would be able to utilise ~500kWh of exported solar energy and allow potential ~40% increase of exported solar generation in the future. However, the network provider shall support the increased solar uptake by reducing the export limits imposed to the households by designing and implementing new innovative network tariffs to support the higher solar uptake on the island.

Reduction in overloading would benefit the customers by reducing potential outages in the future caused by the high peak demand. This cannot be quantified at this stage because the LV outage data is not available.

9.2 Technical

9.2.1 Storing Excess Solar Exports / Increased Solar Hosting Capacity

LV Neighbourhood batteries would play a key role in how quickly the community could transition into 100% renewable energy. Comparing to other forms of energy storage, batteries respond faster to changes in renewable energy generation and enable "shift" in the energy from the middle of the day to night hours. The LV Neighbourhood batteries could address solar export limits by acting as solar sponges on the island and host more solar capacity in the future without restricting network operation.

9.2.2 Deferred Network Augmentation

LV Neighbourhood batteries could provide a way to defer or avoid network augmentation caused by overloading issues on the island. LV Neighbourhood batteries shift peak demand from one time to another which results in creating spare capacity when it is most needed thought the day. Moreover, installing batteries on the island could minimise any future upgrades due to new consumers connected to the network.

9.2.3 Improved Grid Stability

LV Neighbourhood batteries could be valuable assets to the network because of their capability to rapidly increase or decrease the power output which results in improvement of the network stability, frequency, and strength as well as reduction of renewable energy curtailment. A network of LV Neighbourhood batteries could be a building block towards a VPP which would result in a smarter and better coordinated network solution.

9.3 Commercial

The commercial benefits of installation of LV Neighbourhood Batteries on the island are the following:

- Risk sharing – Through 3rd party ownership, the community effectively apportions much of the risk to the 3rd party owner. In return, that owner is likely to expect a share of the benefits
- Route to market – As the community does not currently have strong relationships with retailers a 3rd party with an established market presence can provide this, opening up revenue streams that otherwise wouldn't be available to the asset and helping to pay off the upfront capital cost
- With the route to market also comes the complexity of operating the asset from a commercial point of view. The established 3rd party is equipped to manage all aspects of compliance and reporting associated with operating within the NEM – something that could not reasonably be expected of the community in this instance.

10. Recommendations, Conclusions, and Next Steps

10.1 Commercial Recommendation

10.1.1 Ownership

The revenue that any battery can obtain depends on the intended operation and agreements it has in place. The ownership model determines the distribution of benefits and responsibilities.

The initial recommendation for the project is to adopt a Third-Party ownership approach mainly due to the extensive capability required to operate complex assets of this nature. A Third-Party ownership model also minimises the communities' risk exposure, whilst maintaining the exposure to the project benefits. It should be noted that it may be difficult to secure a Third-Party owner or Joint Venture partner as they will have expectations of a return on their investment. The commercial analysis shows that this is unlikely to be achieved.

10.2 Conclusions

The objectives of the project and the outcomes were:

10.2.1 Provision of information about the best use and configuration of distributed battery storage to enable Phillip Island and other small communities to use more renewable energy faster and more successfully.

The commercial analysis shows the community owned solution is currently not financially viable, due to the upfront capital costs (CAPEX) required ($1.3 - $3.9m). Traditional community-based fundraising activities are unlikely to be able to meet this need.

The estimated financial benefit coming to a community owned battery fleet from power sales (based on current prices) would be insufficient to repay a loan of this size within a reasonable time and within the life of the batteries. The current instability of power prices makes our financial analysis current and not necessarily applicable to the future. This may expose the community organisation to a large financial risk.

It is estimated that CAPEX would need to reduce by 60% and /or a government grant or philanthropic contribution of 70% of current estimated CAPEX would be needed to make a community owned model realistic. While battery prices are expected to reduce, such a large reduction in the costs is unlikely in the foreseeable future. This funding hurdle needs further exploration.

Another option is to reconfigure the battery fleet for example using fewer or larger batteries. Our analysis also shows that would not make the project more likely to succeed because the reduced CAPEX would be proportional to a reduction in power sales.

Third party ownership is the preferred ownership option because third party organisations usually have access to well-established funding sources (through equity and/or debt). Funding from such organisations, coupled with government grants would have the best chance of success with projects such as this. Successful community energy projects in Australia to date have been owned by third party commercial organisations. However, analysis makes this an unlikely proposition due to the financial risk to the third party organisation. It is not financially realistic due to a potentially poor return on the owner's investment. However, a third party, e.g. a power retailer or DSPN, may secure additional income through providing network services or by offsetting network augmentation and distribution costs from establishing the battery network. That may make the project more viable but is most likely to only be applicable if the network issues are severe. A local community or business may find that the high CAPEX is offset by reducing the excessive financial costs of power outages to justify their investment.

10.2.2 Engage residents and businesses in co-designing solutions that meet agreed feasibility criteria

Several pop-up information stalls were provided in the shopping centre and at community events to provide and receive information to/from the community. Regular newsletters, articles in the local paper and Facebook posts kept the Phillip Island Community informed about the project and how they can be involved. Contact details were provided for them to provide and/or receive more information.

An online survey sought the community's views of renewable energy and battery storage. It sought views on interest in more information, how many people have excess renewable energy. The survey also sought views and interest in domestic and community level battery storage.

The community was not involved in co-design as the project was found to be unfeasible and creating community expectation under those circumstances would have been inappropriate.

10.2.3 Analyse social equity outcomes in the energy context

The study investigated options for people who are not able to participate in the transition to renewable energy due to a lack of information and finance. It also looked at different information provision strategies and potential ownership and finance models that might enable those people to participate. 95% of respondents to a recent community survey said YES or MAYBE to considering donating a portion of their excess solar to others in the community to increase social equity.

Social equity outcomes of community batteries will be examined in more detail in our Stream 2 project which looks at use of part of an existing large community battery. Those outcomes can be considered in the small battery context.

The financial analysis showed that third party ownership to be the most likely viable ownership model. This may reduce the potential social benefits to the community due to the owner's need for a return on their investment.

10.2.4 Model improvements in energy resilience and power supply reliability for small end of line communities on the island

Phillip Island includes several small, end of line communities. The site locations for the study included 10 low voltage substations across 6 separate communities across the island. Battery sizes for individual substations based on power demand, solar penetration and substation overload will assist in grid stability and power supply reliability by addressing these issues with the current distribution network.

The technical analysis also showed that LV Neighbourhood batteries could play a key role in how quickly the community could transition into 100% renewable energy. This could occur by responding faster to changes in renewable energy generation and enable "shift" in the energy from the middle of the day to night hours.

Low Voltage Neighbourhood batteries could be valuable assets to the network because of their capability to rapidly increase or decrease the power output which results in improvement of the network stability, frequency, and strength as well as reduction of renewable energy curtailment.

A network of Low Voltage Neighbourhood and community batteries also has the potential to pave the way to future power sharing, community microgrids or Virtual Power Plants which are into smarter and better coordinated network solutions. These Distributed Energy Resources can increase the energy resilience of a community during and following a power disruption due to technical malfunction, an extreme weather event or bushfire.

10.2.5 Offer pathways to improve access to renewable energy

The study looked at a range of community battery project planning matters, including local government planning overlays, approval processes, data requirement and different potential ownership and finance models. The information provided in the report will help other communities to pursue battery projects, in particular small batteries on the low voltage network.

The LV Neighbourhood batteries could improve access to renewable energy by addressing solar export limits by acting as solar sponges on the island. This would enable the network to host more solar capacity in the future without restricting network operation.

10.2.6 Demonstrate ways to avoid network augmentation

Low Voltage Neighbourhood batteries could provide a way to defer or avoid network augmentation caused by overloading issues on the island. Low Voltage Neighbourhood batteries shift peak demand from one time to another which results in creating spare capacity when it is most needed thought the day. Moreover, installing batteries on the island could minimise any future upgrades due to new consumers connected to the network.

The capacity of the Low Voltage Neighbourhood batteries can be sized to address overloading issues (shown by the data) at substations on the low voltage network. The required battery capacity was determined by taking the average substation overloading levels beyond its rated capacity for 2019 and 2021. This approach aims to improve power reliability, avoid network augmentation, and power outages due to high loading.

10.2.7 Provide recommendations about this power storage option to maximise the use of renewable energy for small end of line communities

The technical analysis shows that this power storage option will maximise the use of renewable energy for small end of line communities. However the financial analysis shows that the model explored is not financially viable which creates ownership barriers.

The intended outcomes of the project were:

10.2.8 Qualitative and quantitative environmental, social, technical and economic information about the design and use of LV batteries in this and other small end of line communities/geographical areas to support their transition to renewable energy

The project delivered on this intended outcome. It found that there are few environmental risks associated with this neighbourhood battery model in terms of vegetation destruction, risk to wildlife and bush fire risk when the CFA's and Clean Energy Councils recommendations for battery design, safety standards and ground and vegetation clearance were followed.

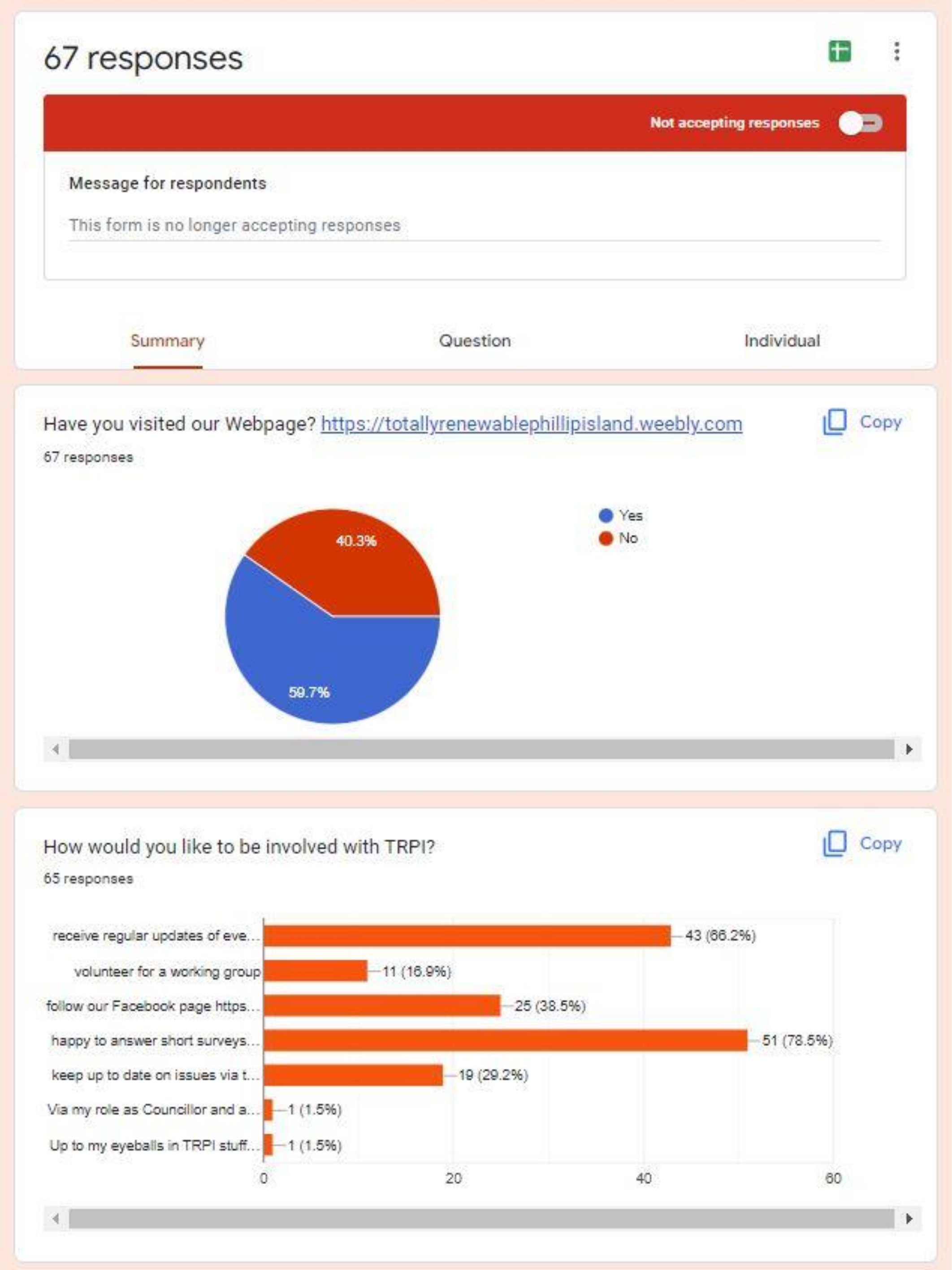
10.2.9 Identified pathways for unlocking economic opportunities and challenges of community batteries e.g. wholesale market and other services to improve the viability of storage in general across the state and beyond

The project team is very disappointed with the report's findings. We had hoped to be able to advocate for financially viable small neighbourhood batteries for small towns and villages on Phillip Island and remote areas of Gippsland and other parts of Australia that do not need and cannot afford larger batteries.

Our role moving forward will be to further investigate cost savings and third party opportunities to pursue the project. If that is successful, we will support the third party through community awareness and education to implement the project.

11. Appendices

Appendix 11.1: Community Engagement Survey Results Analysis



67 responses

Message for respondents

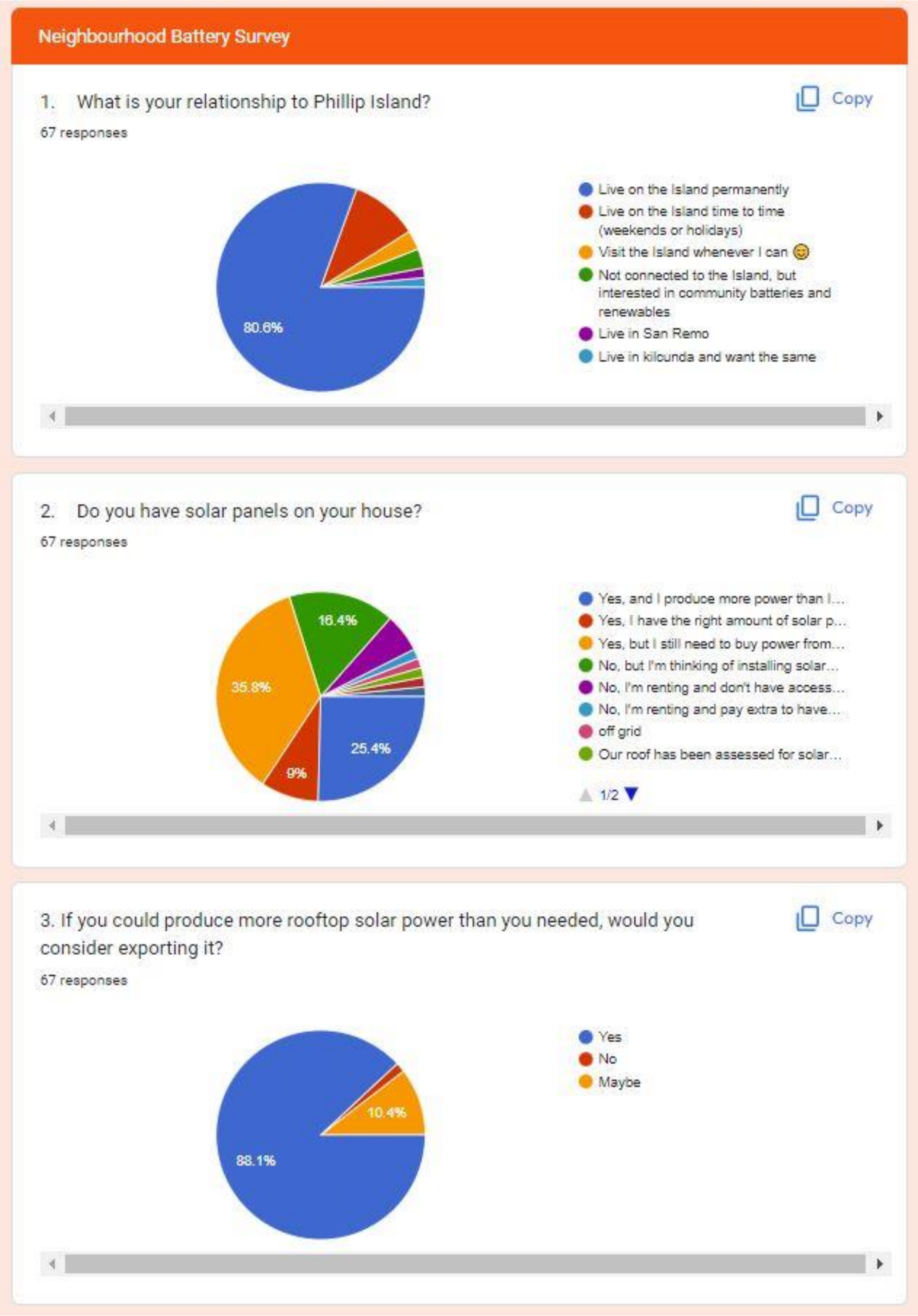
This form is no longer accepting responses

Have you visited our Webpage? https://totallyrenewablephillipisland.weebly.com

67 responses

How would you like to be involved with TRPI?

65 responses



Neighbourhood Battery Survey

1. What is your relationship to Phillip Island?

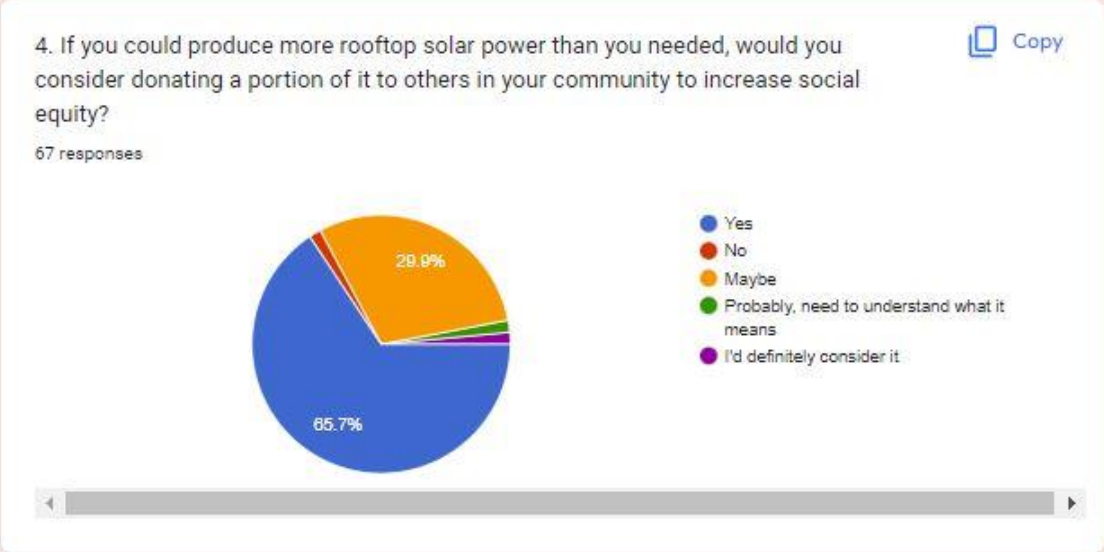
67 responses

2. Do you have solar panels on your house?

67 responses

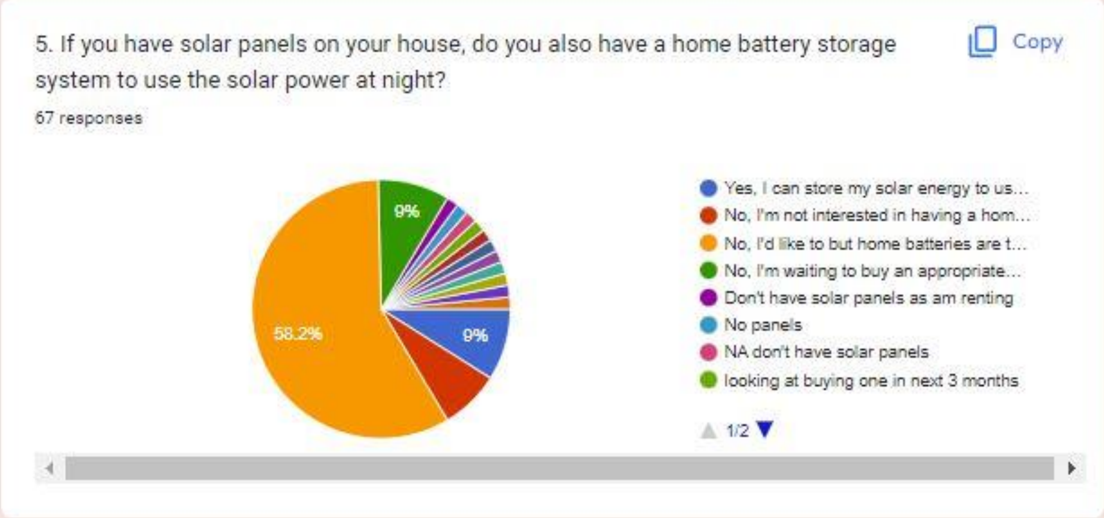
3. If you could produce more rooftop solar power than you needed, would you consider exporting it?

67 responses



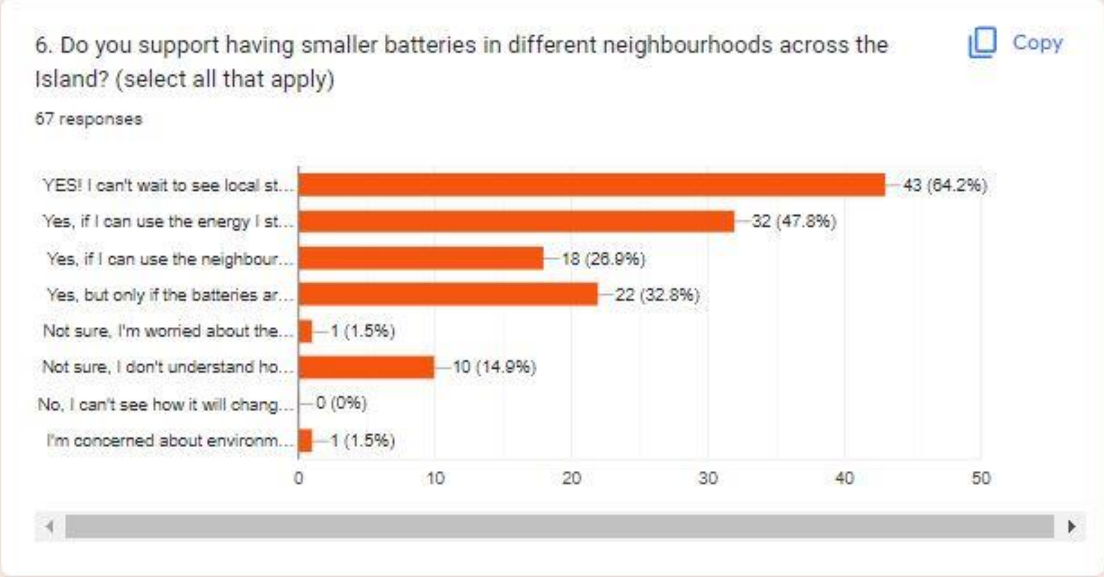
4. If you could produce more rooftop solar power than you needed, would you consider donating a portion of it to others in your community to increase social equity?

67 responses



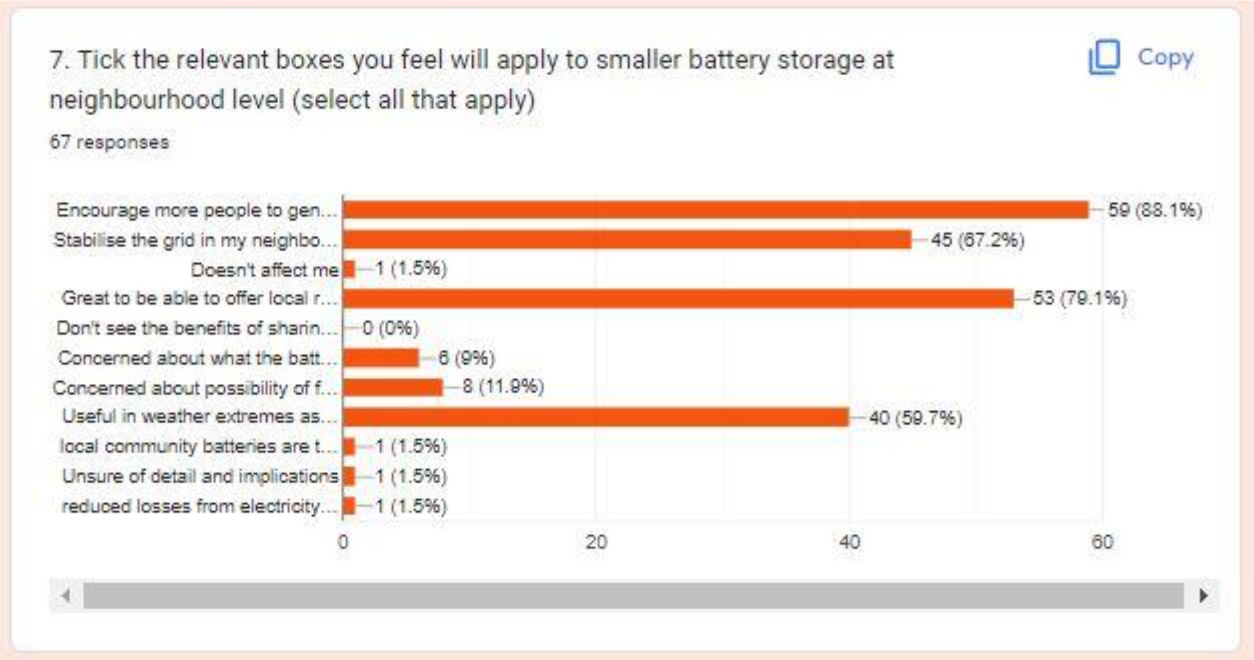
5. If you have solar panels on your house, do you also have a home battery storage system to use the solar power at night?

67 responses



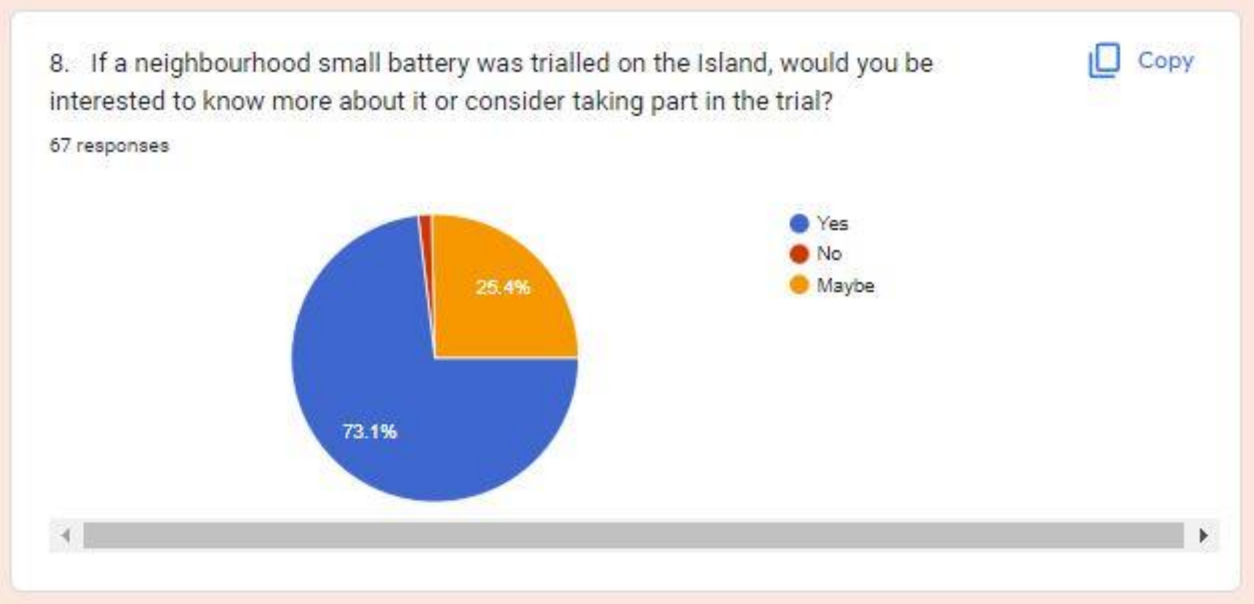
6. Do you support having smaller batteries in different neighbourhoods across the Island? (select all that apply)

67 responses



7. Tick the relevant boxes you feel will apply to smaller battery storage at neighbourhood level (select all that apply)

67 responses



8. If a neighbourhood small battery was trialled on the Island, would you be interested to know more about it or consider taking part in the trial?

67 responses

Appendix 11.2: Commercial Analysis

Yackandandah[15]

Yackandandah is a 274kWh behind the meter community battery which is owned by the local community group Totally Renewable Yackandandah (TRY) and operated by Indigo Power, a community owned energy retailer. The battery is co-located (BTM) with a privately-owned solar array. TRY is interested in transitioning their community to 100% renewable energy and creating islandable microgrids within their community. The project was installed as a pilot and TRY is currently investigating expanding their battery portfolio into the MWh range. In order to meet the project costs, TRY applied for and received grant funding for the battery from the Victorian State Government.

United Energy "Electric Avenue"[16]

Between 2021 and 2023, United Energy will install 40 batteries across Melbourne's east, south east and the Mornington Peninsula. Each of the 30kW batteries has the capacity to service local homes and businesses with up to two hours of energy (66kWh). When complete, the fleet of batteries – which have an expected life span of around 15 years – will store 1.2MW of power and support up to 5,000 customers.

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[15] https://totallyrenewableyack.org.au/watts-happening/yack01-community-battery/

[16] https://www.unitedenergy.com.au/innovation/electric-avenue