Apollo Bay Neighbourhood Battery

Feasibility Study Report

ISSUE/AMENDMENT STATUS

Issue Number	Date	Description
12	7/7/2022	Final

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Executive Summary

This feasibility study has been prepared by Mondo Services for the Apollo Bay-based Southern Otways Sustainable (S.O.S) community energy group.

Community Objectives

The study focuses on the technical feasibility of providing localised energy solutions for Apollo Bay and the surrounding areas of Skenes Creek and Marengo. From community feedback conducted during the feasibility study, S.O.S and the Apollo Bay community have indicated the desire for increased community energy network reliability for short term outages, increased resilience in extreme weather and longer term outages, and to address community concerns including local PV generation curtailment and renewable energy hosting capacity. The community also has a strong desire to be 100% renewable by 2030. For more detail refer to section 3 and 4.2.

Technical Solution

The technical solutions that are considered for the Apollo Bay community include a range of installations located in residential, commercial and network related sites. The technical solutions include the following:

- A network of Low Voltage (LV) Battery Energy Storage Systems
- A Grid Scale Battery Energy Storage System
- An Advanced Grid Connected Microgrid
- Targeted behind the meter resilience

This report recommends the implementation of a 4.95MW/10MWh battery with islanding capabilities as part of an initial staged approach towards an eventual advanced grid connected microgrid in order to best address the technical objectives raised. The benefit of using a staged approach reduces the initial complexity and required capital inherent with implementing an advanced microgrid and an islandable battery allows for increased reliability and solar hosting capacity with the community. Following the initial stage, it is recommended that S.O.S. engage the DNSP, Powercor, to negotiate the operation of the battery in an islanding mode. The Apollo Bay community could also consider the roll out of behind the meter infrastructure, to provide some resilience in the case of longer network outages.

The proposed solution would be able to:

- backup for outages around the 2-hour mark in the worst-case scenario (peak demand);
- create local demand during the day, soaking up excess solar generation and using it to address peak demands in the evening. This would primarily address any whole town MV constraints but would unfortunately only have minor benefits for LV constraints that cause residential export limits;
- support development of an advanced microgrid which would allow the community to realise its ambitions for 100% renewable energy.

At the conclusion of the feasibility study, new information provided by Powercor indicated that the Marengo community exists on a separate feeder (CLC003) to Apollo Bay and Skenes Creek (CLC013) and as such will not be serviced by a battery that is connected to the feeder (CLC0013) covering Apollo Bay and Skenes Creek. Addressing the needs of Marengo should be the focus of future investigation and may comprise of similar recommendations covered in this report.

Ownership Structure

It is recommended that the battery be owned and operated by a third-party to minimise the technical and financial risk to the community. This recommendation is reinforced by community sentiment, gathered during the community engagement phase of the project, which supported a third-party owned model, with limited support for a community owned or joint venture approach. A third-party ownership structure would not necessarily prohibit or impede the use of the battery in achieving the technical objectives outlined above.

Project Costs and Economic Assessment

The battery will require government funding in the form of grants to become financially viable. This grant could comprise up to 49% of the project. The remainder of the upfront capital cost would need to be covered by a third-party owner (or the community if a community ownership model is considered). Funding from the DNSP may be available in the form of benefits flowing from avoided network augmentation, however, Apollo Bay has not been indicated as an area of concern for the DNSP, and this funding has not been included in any assumptions in this report. An analysis of the estimated costs and revenue produces an NPV in the range of -$1.7m (unfavourable) to $400k (favourable). The NPV assessment assumes a level of government funding to make the project viable and has been included in the modelling.

Risks and challenges

There exist some possible risks and challenges associated with the battery in its current form to consider, which include:

- Uncertainty and risk with the battery being able to operate in islanded mode. This would require significant collaboration and cooperation from the DNSP;
- The network may require significant upgrades to accommodate a battery asset;
- Costs outlined in this report may be significantly affected by supply chain issues.

Next Steps

Future actions with regards to project delivery should be the incorporation of a project team to set up the project or engage an EPC to run the project on behalf of the community. An expanded version of the whole delivery model should be provided during the delivery stage, with further details of delivery partner resources and details of key personnel.

Table 1 - Key project data

Description	Unit
Battery Capacity	4.95MW/10MWh
Estimated CAPEX	$9,930,000.0 - $18,300,000.0
Estimated OPEX	$181,000.0 - $335,000.0
Forecast cost savings to network (5MW avoided augmentation)	$1,000,000.0 - $5,000,000.0*
Forecast cost savings to customers	Unable TBC**
Estimated community members positively impacted by project	~2,000
Estimated households connected to neighbourhood battery*	~1,650
What has been your estimated expenditure (ex GST) for local procurement	$4,500,000.0

* Refer to Appendix A
** At the time of writing this report, Mondo was unable to provide an estimate of forecast cost savings based on the available information.

Introduction

Australia is in the midst of an important energy transformation as part of Australia's commitment towards cutting carbon emissions to near zero.

Our energy future will be one that entails a mix of existing and emerging technologies across solar, batteries, electric vehicles, wind farms and hydrogen. Our challenge is to leverage green energy whilst ensuring energy access remains affordable and reliable.

Much of this transformation is being driven by the rapid uptake of Distributed Energy Resources (DER) across households and business. Reinforcing this uptake are growing community-based initiatives for solar and wind farm generation supported by neighbourhood 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 neighbourhood 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 neighbourhood 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, neighbourhood batteries may also offer more equitable access to a wider range of energy users by spreading the benefit of renewables access.

The value of battery storage will only increase over time as Australians continue to electrify our energy system through Electric Vehicle uptake, replacement of inefficient gas appliances and increased solar PV uptake. Energy storage will be critical in smoothing supply and demand to avoid network congestion at local community levels whilst maximising use of intermittent sources of renewable power and facilitating community objectives towards a low-carbon future.

2.1 Neighbourhood Battery Feasibility Study

In 2020, Southern Otways Sustainable (S.O.S.) in partnership with the Apollo Bay Chamber of Commerce (ABCC) successfully secured funding from the Victorian Government to undertake a study to investigate the feasibility of a neighbourhood battery for the coastal cluster of Apollo Bay, Skenes Creek and Marengo.

> ***"It's estimated Apollo Bay spends in excess of $4.5M on power, which is lost to the local economy each year, every year. This transition offers opportunities to empower our community in ways other than just the Renewable Energy goal."***
>
> ***Lisa Deppeler - S.O.S***

The study will assess the technical aspects and business case for a neighbourhood battery and identify a process to distribute values to multiple beneficiaries including residents and local businesses. The project also aims to create a more reliable electricity supply for the Apollo Bay township, which will have a positive impact on local businesses and residents.

Mondo Power has been contracted as the consultant for this project. Since 2001 Mondo Power has been pioneering community mini-grids and regional energy hubs that empower homes and businesses to generate, manage, store and share energy.

The Colac Otway Shire Council has also provided funding for this feasibility study which is expected to be completed by July 2022.

Community feedback is a key aspect of the feasibility study and S.O.S and the ABCC are encouraging residents and business owners to participate in research and provide feedback as the study progresses.

2.2 About Southern Otways Sustainable

Southern Otways Sustainable (S.O.S) was formed in 2018. S.O.S is a not-for-profit community group of volunteers, frustrated and motivated by the lack of government action on climate change.

The group has a vision of achieving a net zero energy future for the local community by way of:

- Building on existing 'Rooftop Solar' capacity through community (Bulk Buy) programs;
- Improving the energy efficiency of local businesses and homes;
- Exploring the feasibility of a neighbourhood battery and micro-grid.

S.O.S is supported by many community partners including the Colac Otway Shire, the Apollo Bay Chamber of Commerce, Great Ocean Road Health and the Barwon Region Alliance for Community Energy.

2.3 About Mondo

Mondo is an energy industry leader with expertise in metering, behind-the-meter energy solutions, community energy hubs, energy management platforms and transmission assets. Our assets deliver energy to over 730,000 customers across Victoria.

Mondo has extensive microgrid and neighbourhood battery experience across regional Victoria as part of the following projects:

Phillip Island Community Energy Storage System (PICESS) - a large-scale 5MW/10MWh neighbourhood battery in Phillip Island delivering energy security to the entire island and accompanied by tariff trials.[1]

DELWP Community Microgrids and Sustainable Energy Program (CMSEP) Development Initiatives in Euroa and Yackandandah where solar, battery, and hot water systems were rolled out in targeted community areas for aggregation.

Mondo also has a significant presence in the Great Ocean Road region having been involved in a number of major community projects:

The Deakin University smart energy microgrid partnership: A $25M renewable energy microgrid in the greater Geelong region. The microgrid supports a 14.5 hectare solar farm and 1MW battery contributing to an anticipated 12,000 tonnes of annual carbon emission reductions. [2]

Geelong+ Community Solar Program (G21): Victoria's largest-ever community solar and battery bulk-buy program incentivising regional Victorian residents and businesses to invest in solar panels and battery systems. The program has contributed to 2.5MW of combined solar and battery capacity across the greater Geelong region.

Apollo Bay Community Solar Program : In 2019 S.O.S joined forces with Mondo Power and City to Surf Solar, to offer the Community Solar Program. Supported by an enthusiastic community the program achieved over 250kW of installed Solar PV and 110kWh of battery storage.[3]

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[1] https://mondo.com.au/community/energy-hubs-and-projects/phillip-island-battery
[2] https://mondo.com.au/community/energy-hubs-and-projects/deakin-microgrid
[3] https://mondo.com.au/community/energy-hubs-and-projects/oceangrove

2.4 Why Apollo Bay?

The townships of Apollo Bay, Skenes Creek and Marengo are situated on the Great Ocean Road within the Colac Otway Shire. The towns have relatively small permanent resident populations (Apollo Bay: 1598[4]), however, populations swell during busy summer months due to tourism. In the case of Apollo Bay, the population swells to in excess of 15,000 permanent residents and holiday makers.

Such a population increase places increased stresses on the energy infrastructure – exacerbated by the location of these towns at the remote edges of the feeder-based network. Energy consumption swells during Summer but also during Winter months as a possible result of inefficient household appliance systems, namely electric hot water units.

The region along the Great Ocean Road was also significantly impacted in the summer of 2015/16 as over 100 properties were destroyed by bushfires and major tourist towns were evacuated – at a time of year when populations were highest. Bushfires also impacted the Otways in January of 2020.

Apollo Bay has a long history of a problematic electricity supply impacting an energy consumption profile of 20GWh each year. Frequent and unpredictable outages typically occur at times of peak demand. Outages at these critical times severely impact the earnings of affected businesses, who rely on peak tourist visitation periods for a profitable full calendar year. There were some 70-80 unplanned outages across the region during 2020[5].

The town is not supplied by natural gas, relying on bottled LPG, which adds to the energy costs and emissions profile of the community.

For these reasons, Apollo Bay, Skenes Creek and Marengo were deemed to be ideal locations to support a neighbourhood battery feasibility study.

[4] 2016 census
[5] Powercor 2020-2021 Annual reporting RIN (AER)

2.5 Definitions and Acronyms

Table 2 – Definitions and Acronyms

Term	Definition
NEM	National Electricity Market
DELWP	Department of Environment, Land, Water and Planning
CMSEP	Community Microgrids and Sustainable Energy Program
AEMO	Australian Energy Market Operator
LV	Low Voltage
MV	Medium Voltage
V	Volts
EV	Electric Vehicles
DNSP	Distribution Network Service Provider
HV	High Voltage
AC	Alternating current
BESS	Battery Energy Storage System
DER	Distributed Energy Resource(s)
FCAS	Frequency Control and Ancillary Services
PPA	Power Purchase Agreement
NPV	Net Present Value
IRR	Internal Rate of Return
EPC	Engineering Procurement Contractor
BOOM	Build, Own, Operate, and Maintain
BOOT	Build, Own, Operate, and Transfer
JV	Joint Venture
OTC	Over The Counter
RAMPP	Regional Australia Microgrid Pilot Program

Report Intent

3.1 Aim

This feasibility study was developed for S.O.S and the Apollo Bay Chamber of Commerce, considering the Apollo Bay area and neighbouring suburbs Skenes Creek and Marengo.

In order to fulfill the intent of this report, the energy challenges facing the Apollo Bay, Skenes Creek and Marengo community are outlined whilst capturing the community's future aspirations. Various technical solutions will be presented and evaluated against criteria formed from the outlined challenges and aspirations. A recommendation on the best fit technical solution for the community will be presented.

3.2 Problem Outline

The town of Apollo Bay and surrounding neighbourhoods of Marengo and Skenes Creek are located at the end of long network connections, resulting in the communities experiencing greater voltage fluctuations, system stability issues and power outages. Flow-on effects range from minor inconveniences through to communication outages, service disruptions and blackouts, sometimes threatening the health and safety of both this community and the many visitors to the town. Power lines into these communities are more vulnerable to extreme weather conditions, including bushfires. This is further compounded by extended response times to address network issues, due to the remote locations and rugged terrain where the poles and wires are situated.

As mentioned, Apollo Bay is a tourist destination town with an influx of temporary holiday makers in the summer months. Network outages are a significant concern for the community with disruptions experienced on a regular basis, and for extended durations. The network area experienced 70 unplanned outages in 2020, with an average duration of 226 minutes per outage, the majority of which occurred in summer. The longest outage recorded was 1,345 minutes (22hr 25min). Of those unplanned outages, asset failure represented 26% of outage duration and 51% for weather events. The Apollo Bay commercial sector, in particular, is affected by outages as the majority are occurring during peak season months, leading to potentially significant revenue losses. For these reasons, the technical objectives of reliability of the network in the case of shorter outages (less than 2 hours), and resilience in the case of longer duration outages (typically lasting more than 2 hours) are important considerations for the community.

The Apollo Bay community has a 14%[6] residential solar penetration, with rooftop export for much of the year higher due to 70% of residences being vacant holiday homes. A proportion of which currently experiences solar curtailment due to grid capacity constraints. The community has expressed desires to be able to increase their proportion of rooftop PV installations.

Given the majority of current rooftop PV installations installed in Australia lack the ability to control the electricity to be exported to the grid, high penetrations of rooftop solar can lead to network congestion in local distribution networks, especially during peak production hours (i.e. middle of the day). This is reportedly a feature of the Apollo Bay area. In order to avoid exceeding the technical limits of the grid and manage this issue today, energy networks like Powercor, (the DNSP for the Apollo Bay region), impose zero or near-zero energy export limits on new solar systems in congested areas.

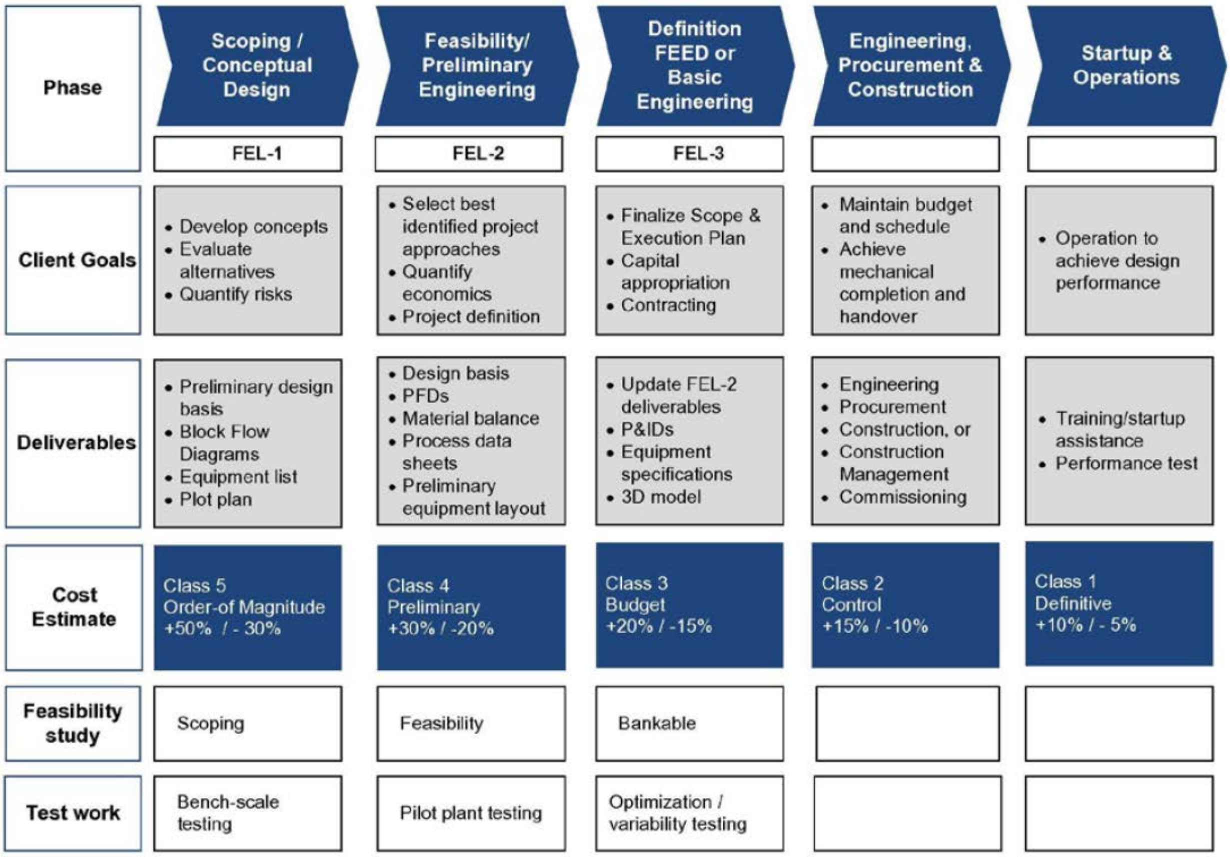
The Apollo Bay community also understands, and is concerned about, the risks posed by climate change. The community has expressed ambitions to become powered by 100% renewable energy by 2030 in order to reduce its impact. As such, the solutions discussed in this report will be assessed against this technical objective.

3.3 The Approach

The industry standard process for developing projects follows a converging path of maturing engineering details and cost estimates. This process steps through five phases beginning with concept then through feasibility, front end engineering design (FEED), detailed engineering procurement and construction and lastly with start-up of operations.

As outlined in Figure 1 below this feasibility report forms the concept level which is a class 5 cost estimate with an expected order of magnitude of +50% to – 30% accuracy range. This is followed at a later stage by the feasibility engineering and cost estimate phase, which can expect an estimate range of a class 4 estimate with an accuracy range of +30% to –20% (FEL-1).

[6] Network usage data provided by Powercor



Phase	Scoping / Conceptual Design	Feasibility/ Preliminary Engineering	Definition FEED or Basic Engineering	Engineering, Procurement & Construction	Startup & Operations
	FEL-1	FEL-2	FEL-3		
Client Goals	• Develop concepts • Evaluate alternatives • Quantify risks	• Select best identified project approaches • Quantify economics • Project definition	• Finalize Scope & Execution Plan • Capital appropriation • Contracting	• Maintain budget and schedule • Achieve mechanical completion and handover	• Operation to achieve design performance
Deliverables	• Preliminary design basis • Block Flow Diagrams • Equipment list • Plot plan	• Design basis • PFDs • Material balance • Process data sheets • Preliminary equipment layout	• Update FEL-2 deliverables • P&IDs • Equipment specifications • 3D model	• Engineering • Procurement • Construction, or • Construction Management • Commissioning	• Training/startup assistance • Performance test
Cost Estimate	Class 5 Order-of Magnitude +50% / - 30%	Class 4 Preliminary +30% / -20%	Class 3 Budget +20% / -15%	Class 2 Control +15% / -10%	Class 1 Definitive +10% / - 5%
Feasibility study	Scoping	Feasibility	Bankable		
Test work	Bench-scale testing	Pilot plant testing	Optimization / variability testing		

Figure 1 - Project phases and expected deliverables and cost estimate accuracy range

This feasibility begins with the phase of engineering detail and costing by defining the technical scope and solution, followed by a review of both regulated and unregulated revenue streams available for the variety of proposed solutions. The ownership models for the proposed solution are also explored in detail.

In addition, the commercial proposition for the final proposed technical solution will be evaluated in terms of estimated costs and the business models that provide a zero Net Present Value (NPV) against future revenue streams.

Technical Solution

This section provides a summary of the technical solution to targeting the four key objectives for the Apollo Bay community.

4.1 Network Technical Information

The following technical information was extrapolated from 30-minute interval energy data from the 2019 calendar year for the Apollo Bay area. Apollo Bay and Skenes Creek are on feeder CLC013 (Colac), and this feeder covers a few other towns with the network managed by Powercor. All of CLC013 is shown to be very stable by the available data - between 240 and 245V.

Table 3 - Network information extrapolated from 30-min energy usage data for CY 2019 – Apollo Bay

		Recorded on
Maximum Demand	4.19 MW	08/06/2019 at 10pm
Average Daily Energy Usage	38.6 MWh	-
Maximum Daily Energy Usage	60.33 MWh	30/12/2019
Maximum Energy Usage (2hr period)	5.81 MWh	08/06/2019, 9:30-11:30pm

Table 4 - Network information extrapolated from 30-min energy usage data for CY 2019 – Skenes Creek

Maximum Demand	0.63 MW	08/06/2019, 10pm
Average Daily Energy Usage	4.2 MWh	-
Maximum Daily Energy Usage	8.3 MW	30/12/2019
Maximum Energy Usage (2hr period)	1 MWh	08/06/2019, 9:30-11:30pm

Table 5 - Network information extrapolated from 30-min energy usage data for CY 2019 – Marengo

Maximum Demand	0.63 MW	27/09/2019, 10pm
Average Daily Energy Usage	5 MWh	-
Maximum Daily Energy Usage	8.9 MWh	30/12/2019

Maximum Energy Usage (2hr period)	1.2 MWh	30/12/2019 1:30-3:30pm

Residential consumption comprised the largest energy use, when compared to agricultural, commercial, and industrial categorisation. For the Apollo Bay region, residential customers export the equivalent of up to 12% of their energy needs (in the form of excess energy) from solar panels in the summer months. This is similar for Industrial customers (up to 11%). Despite the swelling population in summer due to tourism, peak residential energy consumption occurs in winter. The same is not true for commercial & industrial customers - the peak is in January, with a relatively flat load profile throughout the remainder of the year. For commercial customers and domestic farms there is little excess solar generation, for agriculture there is no solar generation.

4.2 Solution Selection Considerations

The initial technical consideration covered by this report will analyse and recommend the best technical approach for the Apollo Bay community based on the items discussed in this section.

Any proposed solution should be able to support the community downstream (Apollo Bay) for a 2-hour period. This period was outlined by the S.O.S community energy group as the target for improving the reliability of the network. Longer outage durations are experienced regularly by the community, with 60% of unplanned outages longer than two hours. This study and future work will take into consideration the cost, technical viability, and community requirements for selecting suitable solutions. The aims and considerations for each area are summarised as follows, based on the issues discussed in the problem outline with the following four key considerations:

- *Reliability* of power supply - overcome the regular outages (short term < 2hrs) that have plagued the town for 30+ years.
- *Resilience* of the town's power supply - in conjunction with supplementary local generation, provide an emergency power supply to the community in the event of longer-term outages (due to bushfires or similar)
- *Grid Capacity constraints* - facilitating the export of surplus domestic PV power to the grid which will encourage residential/commercial uptake of PV and result in better utilisation of local DER
- Increase *Renewable Hosting Capacity* - to accommodate the community's 100% renewable energy aspirations (incl. potential wind/solar generation and micro-grid)

A solution which targets these four areas should include the features outlined in the table below.

Table 6 - Problem/Feature overview

Problem	Feature
Reliability	Short term, immediate response backup; Islanding capabilities (inc. network management)
Resilience	Dispatchable generation; Islanding capabilities (inc. network management) Sufficient backup and/or generation capacity to supply the town for extended outages
Grid capacity constraints	Low Voltage (LV) Energy storage, or demand management
Renewable hosting capacity	Energy storage, network management

Additionally, the following items are also considered when developing and assessing the various technical solutions:

Project Cost

- Minimise existing network augmentation, maintenance, and operation cost;
- Maximise utilisation of existing network assets; and
- Cost effective solutions including:
  - Network and third party owned solutions proposed will seek to minimise costs while meeting project objectives and quality requirements.
  - Customer owned solutions will include an engagement period to ensure that any installed solution will have acceptable benefits (savings, resilience, etc) for the customer owner.

Technical Viability

- Recent reliability performance, and
- Fit for purpose products and ‘right-sizing’ the system
  - how much energy is required, how much surplus is there from solar PV and how much is available to trade on the market (influences the battery charge/discharge cycle)

- Based on historical and predicted community energy use
- Site selection and connection to the grid
    - how far is the network apparatus from the proposed site
    - Quality of the site, including the potential for co-generation with solar/backup generation.

4.3 Technical Solution Options

This section outlines the possible technical solutions available. For the Apollo Bay area, four options have been considered. The options summarised below are not necessarily mutually exclusive from one another and can be combined given the requirements of the project.

4.3.1. Option 1 - LV network Battery Energy Storage System

Option 1 consists of multiple pole top or kiosk battery systems connected to the LV side of the substation and arranged as a network. The network can exist in a front of meter, or behind the meter arrangement. This option addresses issues at the substation and/or street level and could be arranged to create islanding capabilities for the community, depending on the supporting technology and total size of the network. This option would require cooperation with the network, retailers, or aggregators to unlock benefits.

Multiple LV batteries can be coordinated as a network to mimic a larger battery, and from this aspect are more easily scaled than a larger centralised Battery Energy Storage System (BESS).

Table 7 - Option 1 Benefits/Drawbacks

Benefits
- Small individual footprints for batteries, potentially easier to select a site; - Can support network reliability procedures if existing; - Peak demand support/management, enabling deferral of network augmentation; - Alleviate low demand issues e.g. overvoltage, PV export limits; - Increases PV hosting capacity at connection point;

- Relatively (when compared to option 2) simple connection process when BTM; - Increased local energy generation and consumption, reducing losses; - Increased energy affordability for the specific commercial customers taking part in the solution; - Improved network utilisation (and therefore productivity) compared to upgrading the network to address infrequent peak events; - Increased supply of wholesale and market services, placing downward pressure on all customer bills.
Drawbacks/Challenges
- Does not provide resilience for extended outages; - May have islanding capability but might only be able to provide backup for short outages and only for a small area/number of properties; - May need multiple units spread across town/area to provide desired benefits; - Unable to participate in some National Electricity Market activities, while others require partnership with a retailer or aggregator to unlock.

4.3.2. Option 2 - Grid Scale Battery Energy Storage System

A Grid Scale Battery Energy Storage System would comprise of a single large battery connected to the MV network (22kV). The battery would be a front-of-the-meter connection (meaning that it can be "seen" by the network provider for the area). This solution addresses issues at a whole network level and can represent the initial building block for an advanced connected microgrid. Cooperation with the network, retailers or aggregators is recommended to unlock commercial benefits.

Table 8 - Option 2 Benefits/Drawbacks

Benefits
- Participation in National Electricity Market activities, which represents a potential revenue source; - Can support peak demand management, enabling deferral of network augmentation for the network provider, which represents potential support from the network provider;

- Can support network reliability procedures if existing; - Alleviate low demand issues e.g. overvoltage, PV export limits which allows for increases in PV hosting capacity; - Improved network utilisation (and therefore productivity) compared to upgrading the network to address infrequent peak events or constraints; - Increased local energy generation and consumption, reducing losses; - Increased energy affordability for the specific commercial customers taking part in the solution; - Increased supply of wholesale and market services, placing downward pressure on all customer bills; - Increased economies of scale compared to similar storage size of LV battery network (option 1).
Drawbacks/Challenges
- High initial cost; - Suitable site selection; - May have islanding capability but might only be able to provide backup for short outages and only for a small area/number of properties; - Requires a more rigorous connection process when compared to option 1.

4.3.3. Option 3 - Advanced Grid-Connected Microgrids

The advanced grid-connected microgrid is a system built around a network of LV batteries (option "3a") or a grid forming MV BESS (option "3b").

In addition to the battery system an advanced microgrid includes:

- An Microgrid Integration & Orchestration Platform also known as an energy management platform;
- Network augmentation and support to enable microgrid operation;
- Suitable local generation to support objectives where required.

An advanced microgrid can also integrate with and incorporate:

- Essential Services Systems – Solar & Storage with Diesel Generator Backup;
- Businesses (Commercial and Industrial (C&I) or Small Medium Enterprises (SME)) Solar & Storage Systems;

- Electric Vehicles (EV) Charging Stations;
- Demand Management;
- Residential Solar and Storage Systems;
- Additional generation sources.

The benefits and challenges of an advanced microgrid, in addition to those outlined in options 1 and 2 above are outlined in the following table.

Table 9 - Option 3 Benefits/Drawbacks

Benefits
- Higher network reliability and resilience - System can island in the case of a network outage or disaster (when paired with appropriate solar generation and diesel backup, islanding duration can be extended); - Orchestrates any integrated distributed energy resource (DER) to better support the network during grid connected and islanded modes; - Improved reliability and resilience provides another avenue of project payback.
Drawbacks/Challenges
- Regulatory, e.g. in networks with REFCL protection; - Orchestration of different microgrid components for safe and reliable supply; - Highest cost solution; - Technologically complex, requires very high cooperation from network provider.

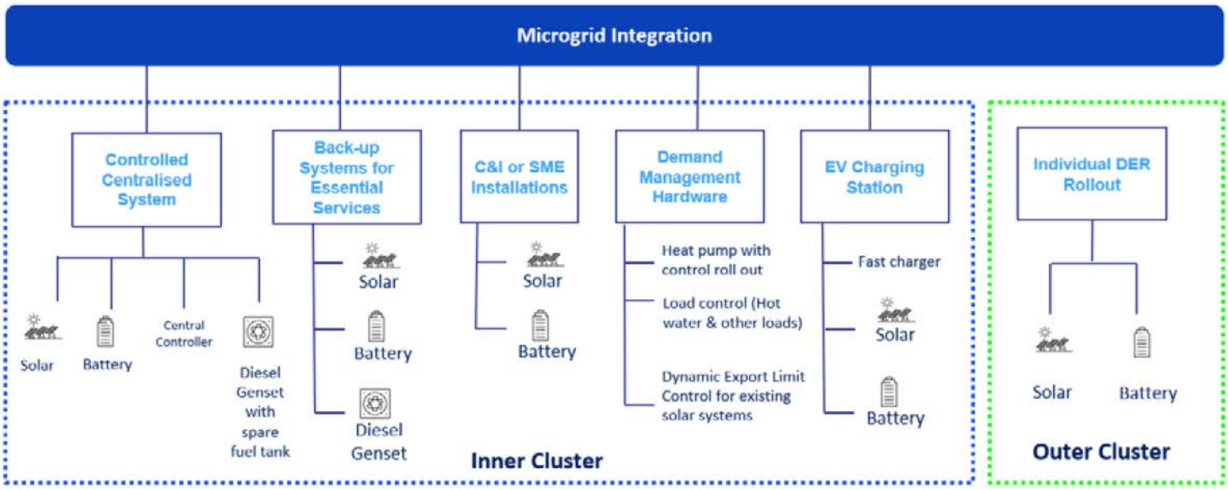


Figure 2 - Example of an advanced microgrid block diagram

The centralised systems are the most critical component of an advanced grid-connected microgrid for supporting a community during network outages, consisting of a grid forming (islandable) battery supported by solar and/or generator connected to one of the 22kV HV (High Voltage) distribution lines. It combines the benefits of renewable and conventional power generation while offsetting the weaknesses.

Advanced grid-connected microgrids provide high flexibility in terms of which technologies the solution incorporates by including focus on an orchestration platform and the integration between technologies. It can also include future installations and new technologies in the network by having them integrated with the existing platforms.

4.3.4. Option 4 - Targeted behind the meter resilience

Targeted behind the meter resilience differs from the advanced microgrid solution above in that it does not have the function of providing backup supply to the wider town during an outage. This solution installs energy resilient backup systems on sites that are deemed essential services or hubs for emergencies where people without access to power can shelter in the event of network outages and emergencies such as bushfires. Additionally, a larger amount of residential solar and storage backup systems can be targeted to minimise the chance of hubs being overwhelmed during emergencies. The number of residential backup systems will ultimately be based on customer interest and uptake after the community engagement. This system is comprised of significant behind the meter resources.

The components that make up this solution can include:

- Essential Services Systems (outlined in section 4.4.3.6) - Solar & Storage with Diesel Generator Backup (short term off-grid supply);
- Businesses (C&I or SME) Solar & Storage Systems (outlined in section 4.4.3.7);
- Electric Vehicle Charging Stations (outlined in section 4.4.3.8);
- Residential Solar and Storage Systems (short term off-grid supply) for outer cluster customers (outlined in section 4.4.3.10).

Table 10 - Option 4 Benefits/Drawbacks

Benefits
- BTM assets have mature connection process and do not need high cooperation from network provider; - Community Resilience for essential services; - Increased resiliency against extended outages during natural disasters; - Relatively simplified solution when compared to option 3 a/b; - Highly scalable and simplest participant contribution; - Can be used in combination with option 1 or 2 as a way of adding resilience for targeted area to the battery solutions; - Solution requires the lowest implementation capital.
Drawbacks/Challenges
- Only limited islanding (resilience to extended outages) ability for essential/targeted areas/sites; - Does not prevent outages for the wider community; - Helpfulness to community as a whole depends on the sites being targeted; - Requires more significant individual contribution and a more targeted community engagement plan.

4.4 Technical Recommendation

A high-level summary outlining the options and their technical suitability is shown in the tables below.

Table 8 outlines the available options and assesses them based on the technical criteria outlined in section 3.2.

Table 9 analyses the four options based on their cost, complexity, footprint scalability and available revenue streams.

Table 11 - Option evaluation table - objectives

Technology (option)	Reliability (outages <2hr & power quality)	Resilience (Longer duration outages)	Alleviate Grid Capacity Constraints	Increase Renewable or hosting Capacity	Recommendation
LV network Batteries (1)	No – only possible when supporting network reliability process	No, the BESS, on its own, cannot supply the network for longer outages	Yes, an LV battery network will be able to discharge during peak demand	Yes, a network of LV BESS can reduce reverse power flow by charging during peak PV hours	Not recommended as does not adequately satisfy the four technical objectives. An LV battery as an initial step building towards option 3a doesn't adequately address the whole town resilience and reliability goals.
Large central Battery System (2)	No – similar to option 1	No, similar to option 1	Yes – similar to option 1 but to a lowered degree due to primarily addressing MV network concerns	Yes	On its own it would only partially address the technical objectives. However, a central MV battery represents the best first stage if the end goal is an advanced microgrid (option 3b) that encompasses the whole town.
Advanced Grid-Connected Microgrids (3a/b)	Yes – microgrid orchestration that incorporates network coordination allows for sections of the network to island	Yes – through a combination of distributed energy resources, demand management, battery storage and backup generation	3a - Similar to option 1 3b – similar to option 2 with increased capability depending on DER integrated into orchestration platform	Yes, this option would allow for the highest penetration of renewables through centralised control and demand management. Dependent on integration.	Preferred solution as it achieves all four technical objectives.

Targeted BTM resilience (Simple Microgrid) (4)	No – only for selected sites	No – however, some selected sites will have resilience capabilities in longer outages	Yes - similar to option 1 and 2	Yes	Would not achieve the same technical objectives as a more advanced microgrid.

Table 12 - Option evaluation table - cost/complexity

Technology	Cost	Complexity*	Footprint*	Scalability*	Available Revenue streams
LV network Batteries (1)	Low/Medium*	Low/Medium	Low	Medium	Network Support Contingency FCAS Aggregation
Large central Battery System (2)	Medium/High	Medium	Medium/High	Medium	Network Support Cont./Reg FCAS Aggregation/NEM
Advanced Grid-Connected Microgrids (3a)	Medium	Medium/High	Medium	Low/Medium	Same as option 1 with addition of islanding network support and aggregation proportional to DER
Advanced Grid-Connected Microgrids (3b)	High	High	Medium/High	Low	Same as option 2 with addition of islanding network support and aggregation proportional to DER

Targeted BTM resilience (Simple Microgrid) (4)	Low	Low	Low	High	Aggregation BTM Savings
Legend	High: > $5M Medium: $500k to $5M Low: < $500k	Low/Medium/High rankings are relative to other options	Low/Medium/High rankings are relative to other options as they are dependent on the size of battery and associated equipment	Low/Medium/High rankings are a measure of how repeatable/upgradable an option is relative to others	

* Price will vary depending on the number of substations targeted to meet objectives

The community objectives outlined above would be well targeted, by an advanced grid-connected microgrid (option 3b). This solution is recommended to be delivered in stages/tranches with the initial activity being the installation of an MV centralised battery with grid forming capability. This should be supported by an orchestration platform integrated with networking monitoring and control signals as well as backup generation to manage peak loads to provide islanding capabilities in the event of outages.

The MV BESS represents a more elegant initial building block when compared to using LV batteries due to the simplified nature of locating a single site for an MV BESS. This is opposed to finding locations for multiple LV BESS units which need to be deployed within community neighbourhoods – requiring more rigorous community buy in and potentially increasing opposition.

Over time as battery and other technology becomes cheaper and the community strives for its ambitions of 100% renewable energy, the diesel capacity could be replaced by additional batteries or larger renewable energy generation assets. Additionally, new DER being installed could also be integrated with the existing microgrid technologies.

As outlined in the table above:

- Option 1 does not meet the full suite of technical objectives outlined – namely the ability to provide reliability for shorter-term outages and resilience against emergencies and longer-term outages. As a building block for an advanced microgrid (option 3a), a network of LV batteries represents a solution more difficult to implement compared to an MV BESS for a similar coverage.
- As a standalone solution, option 2 is not suitable as a long-term strategy because it does not provide resilience against long-term outages and may only have limited islanding abilities. When used as a building block for an advanced microgrid and paired with backup generation, it represents an achievable first step.
- Option 3 meets all the technical criteria outlined in this report and is the preferred solution. 3b is preferred as an option to 3a as the footprint of an MV battery requires less engagement and buy-in from the community and is potentially easier to locate than multiple LV battery installations.
- Option 4 on its own is not suitable because the reliability and resilience benefits it offers to the community are limited to certain key areas and locations. As a standalone solution this does not meet enough of the technical objectives to be considered a suitable solution.

4.4.1. Grid Scale Battery Energy Storage System

As discussed above, an advanced microgrid would meet the technical objectives outlined in this report. A centralised MV battery would represent a valuable first stage and when supported by additional hardware and generation backup, it meets three out of four community objectives.

As mentioned in the previous section and when the full suite of community objectives is considered, the MV BESS represents an ideal initial building block.

Targeted behind the meter generation and storage installations could also be considered to protect vital community hubs in the case of longer network outages and emergencies.

As Marengo exists on a separate feeder to Apollo Bay and Skenes Creek, a central grid scale battery energy storage system would not be able to service the Marengo community. Addressing the needs of Marengo should be the focus of future investigation and may comprise similar recommendations covered in this report.

A summary of how the proposed solution meets the technical objectives is outlined in the table below.

Table 13 - Technical objectives evaluation

Problem	Feature	Solution
Reliability	Short term, immediate response backup; Islanding capabilities (network management)	An appropriately sized MV BESS would be able to backup for outages around the 2-hour mark in the worst-case scenario (peak demand). System would be able to island with the necessary Energy management device.
Resilience	Dispatchable generation; Islanding capabilities (network management) Sufficient backup and/or generation capacity to	An MV BESS on its own would not be able to provide extended outage backup, however, generation backup would be able to assist in the short term. This could be replaced over time with renewable generation.

	supply the town for extended outages	Targeted BTM resilience for key sites could also support the community in the event of an emergency. This solution could be deployed in the short term as the overall advanced microgrid is being developed.
Grid capacity constraints	LV Energy storage, or demand management	An MV BESS would create local demand during the day, soaking up excess solar generation and using it to address peak demands in the evening. This would primarily address any whole town MV constraints but would unfortunately only have minor benefits for LV constraints that cause residential export limits.
Renewable hosting capacity	Energy storage, network management	An MV BESS would support development of an advanced microgrid which would allow the community to realise its ambitions for 100% renewable energy.

4.4.2. Islanding

As discussed in Table 13, an islandable battery allows the community to achieve two of the four technical objectives (reliability and grid capacity constraints) outlined by S.O.S and the Apollo Bay community. However, there are some key challenges with this approach to be considered.

Firstly, a third-party may not gain any additional benefit from an islanding arrangement and therefore would be less supportive of the extra costs and responsibilities – which would add to the need for a portion of funding to be covered by grant funding or the community. This functionality would need to be addressed with any third-party owner, likely during the tender process. This can also be partially mitigated by entering into network support agreements with the DNSP to share the benefits of islanding enablement.

An islandable battery would also require significant negotiations with the DNSP, Powercor, to introduce islanding capability into their network operations. The support from the DNSP is a key requirement since enabling islanding will need their involvement for many activities including but not limited to distributed feeder automation integration and protection coordination, control room operations, field procedures, communication/system integration and connection support. A battery operating in island mode would also require negotiations with the third-party owner.

Should the DNSP be hesitant to accommodate an islandable battery on their network it is possible for the project to progress with a battery that has future islanding capabilities.

The inverters selected and the design of the battery solution (i.e. inclusion of controller, requisite protection system) should ensure that the system can be capable of islanding a portion of the network with minimal augmentation in the future.

The full islanding capability can be realised at a future stage when Powercor expresses their interest in this functionality and will require working together with them. The main drawbacks with this approach are that the project may have to redo islanding studies, protection studies and generator modelling and this would add extra inefficiencies into the project. This approach is additionally reliant on the future plans Powercor has and their interest in the initiative.

However, the main benefit of this approach is that you can progress the project without it being held up by negotiations with Powercor. Similarly, the initial CAPEX may be reduced with such an approach.

Another final option could be to progress with a battery without any future islanding capabilities. This would be the option with the lowest CAPEX and would not require coordination with Powercor. This is generally not recommended as it does not achieve any of the technical objectives outlined by the community and any future work to retrofit the battery to become an islandable asset would be prohibitively costly.

4.4.3. Future steps

<u>Advanced Microgrid</u>

In order to unlock the full value of the initial BESS building block, diesel backup generation and an energy management platform would be recommended from a purely technical position to allow the BESS to island the town in the case of a network outage and act as an advanced microgrid. Over time as battery and other technology becomes cheaper and the community strives for its ambitions of 100% renewable energy, the diesel capacity could be replaced by additional batteries or larger renewable energy generation assets. The energy management platform can also play a role in orchestrating the DER assets in town to better optimise the operation of the microgrid when islanding. Further development in order to better service the technical objective (e.g. protection against longer outages, better resilience for emergency situations and a higher renewable energy hosting capacity) could be delivered in future stages outlined below.

Advantages & benefits:

- Would allow the community significant progress to their 100% renewable ambition;
- Would allow the whole community to operate in the case of a sustained network outage;
- Optimises integrated DER assets installed within the microgrid area.

Drawbacks & challenges:

- Very high cost associated with an advanced microgrid;
- Would require backup generation such as solar & diesel;
- Individual DER installations will have additional integration costs for any orchestration;
- The benefits gained from such an approach may not justify the large investment required, given there would only be a handful of days each year where the battery would operate in an islanded state for an extended period of time.

The layout of the three areas of interest (Apollo Bay, Skenes Creek, Marengo) has been reviewed in relation to an advanced microgrid. The consequent size of a microgrid covering all three areas would be very large and potentially detrimental to the operation/resilience operations of the islanding microgrid. It is, therefore, recommended that the microgrid is only applied to Apollo Bay which has the highest number of connections and includes a large amount of commercial and essential service sites. For reference, Skenes Creek is approximately 11% and Marengo 13% of the load of Apollo Bay.

During emergency events, residents from Skenes Creek and Marengo, including in the surrounding areas, not covered by a microgrid can congregate in Apollo Bay. If it is desirable to have a similar central microgrid solution for Skenes Creek and Marengo then a separate microgrid is recommended to be constructed. Targeted behind the meter resilience and Stand-Alone Power Systems could also be considered for these areas.

Given that resilience was high on the community's original objectives, a more cost effective, albeit less comprehensive approach may be to employ targeted behind the meter resilience as outlined in 4.3.4 and stage 3 below.

<u>Future stages to achieving an advanced microgrid:</u>

Stage 1.5 (optional):

If S.O.S and the Apollo Bay community decide to pursue a battery with future islanding capabilities instead of full islanding capability on installation, stage 1.5 would include engaging the DNSP and/or the third-party to operate the BESS in islanding mode. As previously discussed this would progress the community on its path to 100% renewables and provide reliability in the case of network outages.

Alternatives to this approach could include the update of behind the meter assets as outlined in stage 2 below.

Stage 2:

Could involve a rollout of behind the meter generation, storage and back-up for targeted essential services, this would begin to improve the community's resilience in the face of longer-term outages and emergencies such as bushfires without the high capital cost of converting the town into a full microgrid. The second stage would include the following advanced microgrid components:

- Essential Services Systems – Solar & Storage with Diesel Generator Backup;
- Businesses (Commercial and Industrial (C&I) or Small Medium Enterprises (SME)) Solar & Storage Systems;
- Residential Solar and Storage Systems.

Approaching network resilience like this would represent a cost-effective initial step to making the community more resilient.

Note that this approach can be pursued prior to stage 1 / 1.5 provided that allowances are made for the installations to have future microgrid integration.

Stage 3:

If the decision is made to pursue an islandable battery and the Apollo Bay community seeks to build on a successful implementation, stage 3 could form the final step of the advanced microgrid, allowing the town to become islandable for extended periods of time. This step would include the following components:

- Inclusion of co-generation (e.g. wind and solar farms);
- Further development of energy management platform to optimise DER orchestration;
- Electric Vehicles (EV) Charging Stations (optional);
- Demand Management.

4.5 System Design

Table 9 below outlines the size of the MV Centralised BESS representing the initial building block of the advanced microgrid. The battery component system was sized to be capable of providing full backup power to the area for a duration that would cover most sustained outages, without becoming cost prohibitive, or too technically challenging.

The following preliminary specifications for the central MV battery are recommended based on a high-level analysis of the available 30-minute interval data for the 2019 calendar year provided by Powercor.

Table 9 – BESS and generator sizing

Apollo Bay	
Centralised MV BESS Inverter Capacity	5MW
Centralised MV BESS Storage Capacity	10MWh

* A 4.95MW solution would avoid additional connection/generator requirements at minimal increased supply shortfall risk.

Per table 9, the battery has been sized to have a storage capacity equivalent to at least 120 minutes of maximum load for the worst-case scenario – i.e. maximum demand for a 2-hour period during the 2019 calendar year data. Actual backup time will vary due to a range of circumstances such as the current demand and load during the outage, the operational agreements for the battery, as well as the battery's state of charge and other existing generation.

The inverter capacity of the battery was modelled on the maximum power demand extrapolated from the 30-minute energy usage data for the 2019 calendar year. Storage capacity was modelled to meet the maximum demand recorded over a two-hour period in the 2019 calendar year. A de-rating factor of 20% was applied to the inverter capacity and a 60%* de-rating factor applied to battery size to account for factors such as:

- Voltage network requirements;
- Power Factor;
- Diversification of load requirements (data based on 30-minute energy intervals);
- Temperature rating;
- Battery Degradation over 10 years;
- System Efficiency;
- Area Demand Growth;
- Depth of discharge.

A primary driver is battery degradation over 10 years, other factors mentioned above also contribute to degradation. Due to this de-rating, the amount of backup capacity at the beginning of life is longer than 2 hours, as mentioned above. This degradation can also be addressed with the inclusion of battery replacement or upgrade plans instead of having a larger size at installation.

4.5.1. Solar Generation

For an advanced microgrid operation to operate in a sustained network outage (such as in the case of a bushfire) an MV battery would need to be supported by local generation. A mix of solar generation and diesel backup would be the most economic mix. A 1.5MW sized solar farm would be sufficient to charge the battery system within a day of operation during the summer half of the year.

4.6 Site Selection

A list of shortlisted sites was identified by S.O.S, which include:

- DELWP - Barham River streamside reserve/crown land adjoining Barwon Water's Apollo Bay basin site (Barham River Road) – 'Site 1'
- Colac Otway Shire - former Marengo landfill (Roberts Road) - 'Site 2'
- Barwon Water Marengo Basin (Ferrier Drive) - 'Site 3'
- Barwon Water Apollo Bay Water Reclamation Plant (Montrose Avenue) – 'Site 4'

Of the shortlisted sites identified by S.O.S and outlined in further detail in Appendix D, from an electrical network perspective:

- Site 1 represents the most ideal location for the proposed battery. The nearby connection to the 22kV network appears to be part of the 'network backbone', which is more likely to have a larger network capacity and therefore has a higher likelihood of being able to accommodate the full output of the generating system.
- The nearest connection points to sites 2 and 3, as well as site 4 all appear to be spur lines which are less ideal to connect the proposed battery to. While these locations may actually have the same conductor type (and therefore network capacity) as the backbone, there is a chance that the spurs have reduced capacity and so will more likely require additional line upgrades in order to enable the connection of significant generation capacity. Similarly, sites 2 and 3 appear to be in proximity to the feeder supplying Marengo (CLC003) and would not be adequate for a solution targeting Apollo Bay and Skenes Creek (CLC013).
- Further actions during detailed design, regarding the location of the proposed battery should include confirmation of the connection capacity of the locations in order to determine the extent of any network upgrades that may need to occur to enable the generation connection.

Of the shortlisted sites outlined above, from a land use and planning perspective:

- Site 1 - The Colac Otway Shire Council will need to be engaged to discuss the construction of the BESS on land managed by them. As the land is still classified as crown, direct purchase or easement/lease may not be possible, however, a licence could be. As Figure 5 above shows the available land is approx. 73m wide providing plenty of room for the footprint, however, the land does gently slope towards the south which may require benching to be undertaken.
- Site 2 - Colac Otway Shire will need to be engaged to discuss the construction of the BESS on land managed by them. As the land is still classified as crown, direct purchase or easement/lease may not be possible, however, a licence could be.
- Site 3 - Barwon Water will need to be engaged to discuss the construction of the BESS on land managed by them. Powercor may also need to be engaged if the proposed works encroach into their easements, although consultation with Powercor will be required regardless of site choice.
- Site 4 - Barwon Water will need to be engaged to discuss the construction of the BESS on land it owns.

4.6.1. Connection & Protection Requirements

All of the proposed sites exist on the same feeder of the Powercor network and will be subject to similar DNSP requirements for sub 5MW generation connection. This includes the requirements detailed in the 'Customer guidelines – High Voltage Distribution Connected Embedded Generation' and 'Sub 5MW Generator Performance Standard Guideline' on Powercor's connection page. Additional/adjusted requirements may be stipulated by Powercor based on the network conditions at the connection point, such as additional control schemes to accommodate upstream events on the network (faults, underloading, overloading, etc.).

In addition to the above, in order to enable network islanding, further control and protection requirements will need to be in place on site. These exact requirements will be determined in detailed discussions with the DNSP but can include things such as:

- Islanding allowance signal to DNSP to ensure the system doesn't island by mistake;
- Upstream Synchronization signal to allow reconnection to the network;
- Additional site status integration with DNSP systems;
- 22kV Neutral-Earth switch on site that closes during islanded operations;
- Additional set of protection and control settings for islanding operation;
- Protection settings to accommodate fault conditions during islanding.

4.6.2. Network Constraints

The exact network constraints (and subsequent network support potential) on the above sites will require further engagement with the DNSP to determine. However, based on network engagement provided by S.O.S for another site in the region, various high-level conclusions can be determined on the potential for a large battery connection in this region. This analysis is done for information purposes only and does not replace the detailed discussion required with the DNSP for determining what's possible and required for a new connection.

The information provided by S.O.S had the following connection feedback:

- Colac (CLC) zone substation isn't constrained;
- Upstream terminal stations from CLC likely aren't constrained;
- The connection between CLC and upstream terminal stations may experience thermal constraints at times for generation;

- The CLC Feeder does not have 2.5MW of charging capacity. 1MW or less of charging is recommended;
- The CLC Feeder does not have 4.95MW of generation (ie. export) capacity. 2.5MW or less of export is recommended;
- Network augmentation may be required to address voltage stability;
- Approximately 10km of line augmentation required for 2.5MW of export;
- System studies required to confirm the above;
- Feedback is specifically for distribution network.

The capacity limitations mentioned above would benefit from further discussion to determine the methodology utilised. Although static charging limits have been provided in the feedback, it is noted that when assessing the load profile of Apollo Bay, it greatly varies throughout the day and seasons (reaching a maximum over 4MW at its highest). This implies that the 1MW limit that is mentioned may be based on worst case scenarios that don't accommodate the actual operation profile of a battery. This is similar for the generation, however, in reverse and also relates to how much line augmentation it's estimated is required.

While further discussion is still required to clarify the above, it is apparent that any battery system that is installed will benefit from a control system that is more extensively integrated with the DNSP. When combined with the flexible capability of a battery, it provides the possibility of maximising the battery operation while also potentially supporting the network at the same time. One example of this is that the loading or availability of the feeder can be a DNSP input into the site control system that would then ensure that the battery doesn't exacerbate any feeder constraints. This kind of integration/agreement with the DNSP can also go a step further, where the battery can operate to help alleviate network constraints under a network support agreement with the DNSP.

It should also be noted that for a system to be able to island Apollo Bay, it is not necessarily required for all upstream constraints to all be addressed since when islanding, only the 'local' network remains connected. However, it is greatly beneficial to have fewer constraints upstream to allow the battery to more optimally operate during grid connected BAU.

Community Engagement

At the time of this report, S.O.S. and Mondo have collaborated on a community engagement strategy which has focused on acquiring feedback and buy-in from the local community of Apollo Bay, Skenes Creek and Marengo on two key issues. The first of which involved determining what were the most important issues facing the community in terms of their local energy supply. This information was used to help determine the technical solution proposed in this feasibility study. The second engagement involved determining community sentiment towards the various ownership structures available to a neighbourhood battery given the various risks and benefits of each model.

Future community activity engagements will focus on knowledge sharing through community town hall meetings, where S.O.S. and Mondo will provide project updates and address any questions or concerns that the community may have on the proposal.

With regards to the first phase of community engagement, the residential and business community were asked to rate their preferences for which technical objectives were most important. The residential community rated ‘100% renewable’ then ‘reliability’ as more important than ‘resilience’ with ‘increased capacity for solar’ a last priority. The business community provided similar results, however, rated ‘reliability’ as slightly more important than ‘100% renewable’.

For the second phase of community engagement, the results pointed to a preference for a third-party owned model to operate the battery.

Refer to appendix F for a further description of the community engagement including key results from both stages.

Business Model

6.1 Ownership Structure

In general, for the Apollo Bay neighbourhood battery, three possible ownership structures could be considered: community owned, a joint venture agreement or third-party owned. For further information on each model refer to appendix C.

Ownership/Revenue Summary

The revenue that a battery can obtain depends on the operations and agreements it has in place. The ownership model determines the distribution of benefits and responsibilities. A summary of the different ownership structures challenges and benefits are in Table 14 below.

Table 14 - Ownership structures, benefits and challenges

Ownership structure	Benefits	Challenges/risks
Community owned	- More say in the battery operation; - 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 battery	- 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

It should be noted that any third-party owner or Joint Venture partner will have expectations of a return on their investment.

Given the feedback gathered from the community engagement initiative on ownership structures and the benefits and challenges outlined in Table 14, it is recommended that S.O.S. adopt a Third-Party ownership approach. Given the lack of community appetite and inherent risk with a community owned and joint venture approach, as well as the lack of proven examples for successful projects from which to draw upon, a community owned, or joint venture approach is not generally recommended.

A third-party ownership model exposes the community to the least amount of risk. Whilst there is a risk that the third party and community's objectives won't be aligned, this can be mitigated through negotiations and a tender process.

6.2 Key Parties

Within the ownership structure and business models, there are a number of key stakeholders to consider, these include:

The retailer: responsible for the relevant market settlements of the costs.

Network Operator (DNSP): Powercor is responsible for the operation, maintenance and upgrade of all physical network assets upstream of the customer connection point. In addition, this may include the revenue-grade metering of the neighbourhood battery in which case, Powercor would also be responsible for provision of the meter data to a retailer. To enable a connection to the network, Powercor is responsible for outlining the connection process and any technical requirements that must be met in order to connect the asset. Should network islanding be enabled for this community then Powercor will need to coordinate their network assets with the battery to allow safe operation as well as potentially upgrading their network and processes to suit the new mode of operation.

Asset owner: This is the owner of the MV battery. This will either be a third party or the community itself and depending on the ownership model chosen, the owner may be separate from the operator of the battery.

6.3 Project Costs & Economic Assessment

6.3.1. Model Inputs and Assumptions

The total project costs include capital and operational expenditures over the design life of each solution package. The model is based on the following assumptions and exclusions:

Assumptions

- Cost estimate accuracy of ± 30%
- The system configuration is only indicative
- Design life for the MV battery is 15 years

Exclusions

- Construction specific costs not included beyond the +/-30% margin
- No allowance has been made for environmental studies
- No allowance has been made for additional network connection works
- No allowance has been made for permits or planning complexities such as discovering cultural heritage on site.

6.3.2. Economic assessment

An indicative scenario analysis has been developed for this service and is based on the general cost assumptions as provided in above and on the technical system descriptions provided in Section 4 of this report.

The analysis is an indicative cash flow modelling exercise and does not take into consideration the requirements and commercial positions of the parties involved which may influence items such as estimation of fixed and variable revenue streams, pricing of risks, return expectations, offtake agreements etc. A detailed assessment would require further consideration to such variables and potentially a comprehensive market sounding and/or procurement exercise for greater accuracy. It should also be noted that this revenue stack is accessible regardless of the ownership structure.

With regards to the areas for funding, three contribution components should be considered:

- Government funding grants which could constitute up to 49% of the project and would increase the likelihood of third-party funding. Government grants would be required to provide funding that is not subject to an internal rate of return, usually expected by a third-party investor. Funding has been included in the NPV assessment. Government funding options are considered in section 10.4.4;
- Potential DNSP contribution. Given this is highly variable it is not included in the modelling. This option is evaluated in more detail in Appendix A;
- Third party or community funding for the remainder, dependant on the ownership model chosen by the community.

The revenue and cost (CAPEX/OPEX) were modelled with a sensitivity analysis using the determined most likely scenarios. The outcome is shown in the table below. The NPV was modelled assuming a government funding contribution of 39%. Note that the results below exclude the costs to make the battery fully islandable but includes components to make the battery island-ready for the future. A solution package cost summary can be found in Appendix H.

Table 15 - Project financial metrics

Metric Name	Results
Total CAPEX	$9,900,000.0 - $18,000,000.0
Total Revenue	$7,400,000.00-$13,700,000.00
Project NPV (IRR of 8.65%) *	-$1,700,000.00 to $400,000.00

* Modelled with inclusion of government funding at 39% of project cost.

Based on the financial analysis there is a high likelihood that there will be a gap in the commercial case. This gap refers to the shortfall in revenue created by the project compared with the upfront and ongoing costs of the battery. The battery system is likely to be **not financially viable** and would struggle to attract third party owners and investors without additional government funding.

6.3.3. Recommendations

Given the likely shortfall, a list of possible next steps or actions to make the project financially feasible may include the following:

Reduce the size of the system

Reducing the size of the system to reduce capital and operating costs. LV batteries may be considered here, these would realise many community benefits, such as acting as a solar sponge, and reducing outages on localised areas of the network, as discussed in section 4. These could be complemented with targeted behind the meter resilient backup systems on sites that are deemed essential services or hubs for emergencies where people without access to power can shelter in the event of network outages and emergencies such as bushfires.

Seek grant funding to close the gap

Possible avenues for funding could include:

- RAMPP (Regional Australia Microgrid Pilot Program) funding from ARENA;
- DELWP funding;
- Risk and Resilience Grants program (Energy Management Victorian).

Delay the project

Consider delaying the project for a number of years until the cost of lithium-ion batteries has reduced. This option would allow the project to be financially viable in the future whilst maintaining the same technical specifications. Whilst the cost of lithium-ion batteries increased for the first time in 2022 due to supply chain issues and increased demand, they are still predicted to reduce in cost over the coming years.

Quantify the value of reliability for the community

The community could quantify the value put on improving the reliability of the network which would improve the economic assessment of the project.

Factor in impact of possible future scenarios

Possible future scenarios may improve the revenue potential of the battery. These would include further economic analysis to factor in the likelihood/risk of occurring:

- Introduction of an emissions trading scheme. A future government action may be to introduce an emissions trading scheme. This would improve the revenue potential of the BESS as it would increase the amount of renewables on the grid which would in turn increase the need for peaking support (support around the “peak” times, usually occurring in the early evenings, or at the tail of the solar ‘duck curve’);
- The extension of the Renewable Energy Target would have a similar effect to an Emissions Trading Scheme.

Project Delivery

7.1 Project Delivery Team

The next immediate action with regards to project delivery should be the incorporation of a project team to set up the project or engage an Engineering and Procurement Contractor (EPC) to run the project on behalf of the community. An expanded version of the whole delivery model should be provided during the delivery stage, with further details of delivery partner resources and details of key personnel.

7.2 Delivery Solution Summary

Since this feasibility report provides an overview of the overall delivery based on a preliminary design, there are various aspects that would require a step further into detail/tender design, community engagement and market testing to refine the delivery approach. Overall, the recommended delivery approach is summarized into the following stages:

Figure 3 - Delivery Solution Summary

Incorporate project team (1-3 months)

- This phase commences after the approval of the feasibility report.
- Incorporate a stand-up project team or go to an EPC who runs the project on behalf of or in partnership with S.O.S.
- Additional funding should be sought here in order to carry out the preliminary works.

Preliminary works (3-6 months)

- This phase commences after the project team has been incorporated.
- Aimed at refining the business case by stepping further into tender design for the neighbourhood battery.
- Provides an opportunity to deep dive into feasibility, market testing and community engagement before committing to a large expenditure approvals.

- At the end of this phase, project should be in a shovel ready state, i.e. groundwork is done so project can go ahead.
- Activities should include:
    - Detailed cost estimation with +/- 10% margin
        - Market pricing test
        - Tender documents and process
    - Connection enquiries
    - Initial stakeholder engagement
        - Council
        - CFA
        - DNSP
    - Site selection/confirmation
    - Landholder lease agreements
    - Technical Specifications
    - Funding/Revenue investigation
    - Business case and model development

<u>Pre-Delivery (3-12 months)</u>

- Business case finalisation and funding to be sought and finalised based on the outcomes of the preliminary works for the rest of the project, this could include (but not limited to)
    - ARENA RAMPP (Regional Australia Microgrid Pilot Program)
    - DELWP funding
    - Risk and Resilience Grants program (Energy Management Victorian)

<u>Execute (9-15 months)</u>

- Implementation is estimated to be 12 months, subject to international supply chain constraints
- Detailed Design
- Procurement
- Development Application
- Connection application and studies
- Construction
- Testing and commissioning
- Fully functional MV battery at the conclusion of this stage

Appendix

8.1 Appendix A: DNSP (Powercor) information

8.1.1. Network Support

Avoided network augmentation can be valued by the DNSP in the order of $0.2 - $1.0m per Megawatt of capacity. This has been outlined as a reference, but not included in the economic analysis. Total estimated Powercor revenue potential given the battery's ability to provide 5MW of avoided network augmentation is in the range of $0 – 1,350,00.00. Note that this is a potential benefit to the network *if* network augmentation is required.

Powercor participates in the Service Target Performance Incentive Scheme (STPIS) which encourages improvements in reliability by setting targets and penalties in relation to customer outages. A battery that can island part of the network and help Powercor achieve its STPIS targets could potentially be eligible for revenue equal to a portion of the avoided penalties.

The avoided penalties are up to $1.5M* based on 2020 outage data, although this benefit is limited to the next STPIS target reset period and so cannot be claimed perpetually. This value is outlined as a reference, but not included in the economic analysis. The total estimated Powercor revenue potential given the battery's ability to provide islanding for Apollo Bay is in the range of $0 – $200,000 per annum.

*This was approximated using the following information:

- AER's Powercor determination for STPIS 2021-2026
- AER's Powercor determination for Revenue 2021-2026
- Apollo Bay outage data from 2020
- Powercor total customer count assumed as 870,000 from their DAPR
- Assumed that 20% of customers are connected to feeders classified as 'Rural Long'
    - This is the same as Apollo Bay

8.1.2. Powercor tariff factsheet

Community-Battery-Trial-Tariff-factsheet

8.1.3. Powercor Easement

CHED0065_FactSheet_ApolloBay_V2.pdf

8.2 Appendix B: Case Studies

Yackandandah[7]

Yackandandah is a 274kWh behind the meter battery instigated and owned by the local community group Totally Renewable Yackandandah (TRY) and operated by Indigo Power which is 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.

Phillip Island [8]

The Phillip Island BESS is a 4.95MW/10MWh Lithium-Ion Battery and is owned & operated by Mondo. Its primary role is to play a network support role, reducing the need for network upgrades and maintenance on the AusNet network. It also participates in market activities (e.g. FCAS trading and Energy arbitrage) to generate revenue/returns.

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

[8] https://mondo.com.au/community/energy-hubs-and-projects/phillip-island-battery

MAGS[9]
The Mallacoota Area Grid Storage System is a 1MWh BESS owned and operated by the DNSP (AusNet). It was installed to provide power to the town during the frequent outages on the feeder which is particularly prone to problems caused by storms, vegetation and wildlife.

Hornsdale Power Reserve (HPR)[10]
A 150MW/193.5MWh battery owned and operated by Neoen Energy. Neoen is a large international renewable energy developer with multiple projects in Australia. HPR participates in NEM activities through FCAS and energy arbitrage services. The Hornsdale Battery was able to recuperate its costs fairly quickly, mainly through FCAS trading, by being a 'first mover' with regards to a large battery on the NEM.

Alice Springs "Big Battery"[11]
A 5MW/4.6MWh battery owned and operated by Territory Generation (who are owned by the NT government). The battery was funded by Territory Generation. The battery was primarily installed for generation stabilisation, however, generates revenue by providing grid stability and increasing the penetration of solar in the area. Vector Energy, a New Zealand Engineering firm were responsible for designing, engineering, constructing and installing the battery as well as taking responsibility for operations and maintenance. Modelling conducted by engineering firm Aurecon has determined that the cost of the battery system is expected to be recouped within four to five years due to efficiencies and savings.

MPower 1.5MWh BESS trial & BESS network[12]
A renewable energy developer, who is reportedly installing a series of 5MW batteries co-located with solar farms after the successful trial of a 1.5MWh battery on the Endeavour Energy network (NSW DNSP). The trial was designed to assist in reducing network costs, augmenting grid supply and reliability to customers in the Illawarra region of NSW. The batteries will be owned, operated and funded by MPower.

Gippsland BESS[13]
E22 is installing a 5MW/7.5 MWh Li-ion battery in Longwarry, VIC which aims to provide AusNet with many network services in particular during periods of summer congestion. The battery will be owned, operated and maintained by E22.

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[9] https://www.ausnetservices.com.au/en/About/News-Room/News-Room-2018/AusNet-Services-to-Install-Gippslands-First-Big-Battery-at-Mallacoota
[10] https://hornsdalepowerreserve.com.au/
[11] https://www.pv-magazine-australia.com/2018/11/09/5-mw-battery-storage-launches-in-alice-springs/
[12] https://www.mpower.com.au/post/landmark-battery-storage-project-reaches-major-milestone
[13] https://www.pv-magazine-australia.com/2020/11/26/spanish-newcomer-e22s-5-mw-li-ion-battery-to-provide-network-services-in-west-gippsland/

Yarra Energy Foundation (YEF)[14]

Yarra City Council established the YEF as an independent not-for-profit in 2010, and the council remains the core funder. YEF partners with others to bring expert sustainability services beyond Yarra's borders, and are governed by an independent board of directors. YEF also leads the Metropolitan Community Power Hub, funded by Sustainability Victoria. Among the number of projects YEF has been involved in, the latest has been the installation of a 250kWh battery in north Fitzroy.

8.3 Appendix C: Community Ownership overview

Community owned battery

Under this ownership structure, the community would own the battery 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 battery 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 battery. Alternatively, the community could loan the funds to a community-run holding company where the holding company owns the asset (i.e. 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 and/or the Chamber of Commerce form the structure), public and private companies.

Example – Yackandandah (see section 8.2)

Third-Party owned

Under this ownership structure, a third party would own and operate the battery. Possible third-party owners are outlined in Figure 4 below. During the project development, construction, and operations, the community will be a key stakeholder providing input into the battery but otherwise by default is not involved in the day-to-day operations (except passively experiencing the benefits) unless an agreement is in place.

Example – Phillip Island BESS (see section 8.2)

[14] https://www.yef.org.au/

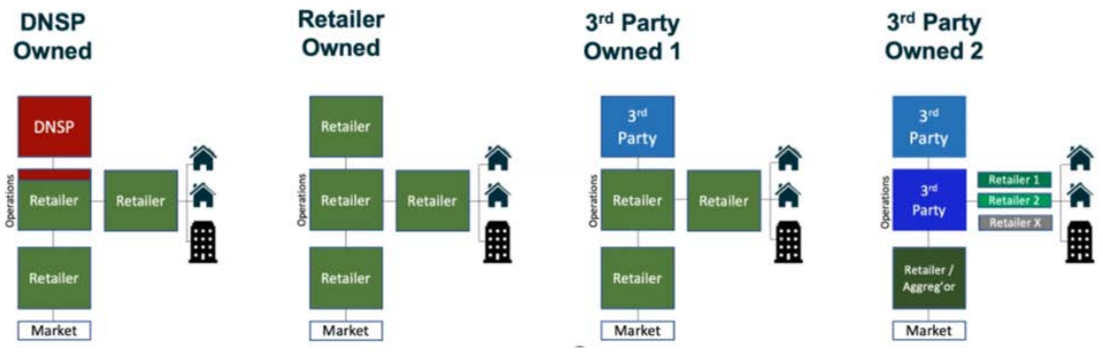

Figure 4 - Third Party owned potential structure

<u>Joint Venture</u>

Under this ownership structure, the battery 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.

8.4 Appendix D: Site Selection

8.4.1. Planning permits

Planning permits – Battery over 1MVA

As of Amendment VC192 (16 March 2021) whereby Clause 72.01-1 of the Victorian Planning Scheme was amended, the Minister for Planning is the responsible authority for new planning permit applications for all energy generation facilities or facilities that store electricity of 1 megawatt or greater.

Applications will need to be made via DELWP, starting with a free pre-application meeting with DELWP representatives and progressing through several stages until a permit is granted.

DELWP may seek additional information prior to approving the permit such as the following (site dependent):

- CFA input;
- Environmental Input (Arborist/Environmental Consultant);

- Offsetting of Vegetation;
- Aboriginal/Non-Traditional Landowner Cultural Heritage Impacts.

Vegetation removal permits which are normally handled by councils, will also be included in the DELWP permit process, however, the same information which would be supplied to council will need to be provided to DELWP.

The High-Level Desktop Assessment will, therefore, not cover permit triggers under the zone(s) due. However, it will provide information and recommendations based on the overlays, native flora/fauna and cultural heritage within the proposed works area.

On 30 May 2022, the Minister for Planning approved Amendment VC220. Published in the Victorian Government Gazette, the notice relates to changes to the Victoria Planning Provisions (VPP) and all planning schemes in Victoria to support the delivery of neighbourhood batteries into the electricity distribution network by amending Clause 73.03 Land use terms. The changes include 'a battery connected to a section of the electricity distribution network operating with a nominal voltage not exceeding 66,000 volts' in the definition of 'minor utility installation' and removal of 'including battery storage' in the definition of 'utility installation'.

8.4.2. Shortlisted sites

The following table does not represent an exhaustive list of site assessment criteria.

Table 16 - Site selection overview

CRITERIA:	**Site 1: Barham River streamside reserve adjoining Barwon Water's Apollo Bay Basin (Barham River Road)**	**Site 2: Colac Otway Shire – Former Marengo landfill (Roberts Road Marengo)**	**Site 3: Barwon Water Marengo Basin (Ferrier Drive – Marengo)**	**Site 4: Barwon Water– Apollo Bay Water Reclamation Plant (Montrose Avenue)**
Location: Distance/visibility/access/ Noise	Located next to water reservoir. Crown land. 3km SW of Apollo Bay town.	Relatively (c. 200m) close proximity to residential area. 0.5km west of Marengo town centre.	Close (c. 20m) proximity to residential housing. High visibility from main road.	Close proximity to industrial estate & treatment plant. Private land.
Area:	0.40 HA total	3 HA total	0.53 HA total	0.36 HA total
Current Land Use: Degraded? Opportunity cost Complimentary uses potential neighbouring uses/compatibility	Open area next to reservoir. Not highly visible from nearest main road. Barwon Water says the area identified on the map is mostly within the crown reserve, not Barwon Water land - suggest focussing on the crown land, instead of Barwon Water land.	Degraded land – former tip site. Not highly visible from main road, high visibility from access road (Roberts Road).	Within Barwon Water's Marengo basin site. Identified area is largely occupied by water, power and communications infrastructure. Transmission Australia infrastructure (satellite dishes etc.) on site, area fenced off to the public. Barwon Water suggests a limited area, if any, may be available. Could the	Open area next to wastewater treatment plant. Not highly visible from nearest main road. Barwon Water says the area marked is largely occupied by site roadways & accessways - not likely to find space in this location. Could the private land (paddock) adjoining the site be considered?

			private land on the opposite side of Roberts Road be considered?	
Planning & Environmental: Zoning Overlays (BF/Flooding/other?) Cultural /native veg assess?	PCRZ Property is covered by Aboriginal Cultural Heritage Overlay. A Cultural Heritage Desktop Assessment will be needed, with the high likelihood of a full Cultural Heritage Management Plan (CHMP) being required. As it is unlikely that the proposed works will disturb less than the 25m2 ground disturbance trigger. A planning permit will be required to remove, destroy, or lop native vegetation. Unless the native vegetation removal is less than 20% of the biomass of the vegetation. Works - As a permit is already being triggered under the zone, a second one won't be needed under the LSIO. However, DELWP will ask for extra assessments and information to be provided to them due to the	PUZ6 A planning permit will be required to remove, destroy or lop native vegetation, unless said vegetation is dead or less than 20% of the biomass is to be removed. A planning permit for subdivision will need to be applied for with the Colac-Otway Shire Council. This permit process is outside of the DELWP planning permit for the works. An environmental assessment will be needed, due to the presence of native vegetation and the multiple vegetation specific overlays. The property is a former mill and therefore is registered on	PUZ1 A planning permit will be required to remove, destroy or lop, native vegetation. A planning permit for subdivision will need to be applied for with the Colac-Otway Shire Council. This permit process is outside of the DELWP planning permit for the works. An environmental assessment will be needed, due to the presence of native vegetation and the multiple vegetation specific overlays.	PUZ1 A planning permit is required to remove, destroy or lop any native vegetation (unless the vegetation is dead). An environmental walkthrough will need to be undertaken prior to works, due to the dual vegetation specific overlay and Clause 52.17 being present. The follow up report will only be needed if vegetation likely to trigger a planning permit (as per the overlays) is located. Changes to the EPA regulations in 2021 has deemed it essential for purchases of properties to undertake Soil Contamination Assessment(s) prior to

	risk of inundation on the land (see decision guidelines). Subdivision - A planning permit will be required to subdivide the land, the same decision guidelines will apply. This permit process will be undertaken by the council, not DELWP. An environmental assessment will be needed, due to the presence of native vegetation and the multiple vegetation specific overlays.	the Victoria Unearthed database as previously being used as a landfill. As per the new regulations a Contamination Consultant will be needed to undertake a Baseline Contamination Assessment prior to utilising land. A Cultural Heritage Desktop Assessment will be needed, to determine what types of artefacts were found within the registered location, if they're still there and what depth they were located at. Best Case –The artefact is no longer there and/or the finding was minimal and the works can proceed without a Cultural Heritage Management Plan. Worst Case –The artefact is still there and the impact of the ground disturbance works (which will be over 25m2) will trigger a full Cultural Heritage Management Plan.	If this site is selected, a Contamination Assessment Consultant will need to be hired to undertake these assessments. A Cultural Heritage Management Plan will not be needed. However, it is advisable to limit impacts on the southern section of the property.	undertaking the purchase and reporting any findings to DELWP. Therefore, despite nothing showing on the database, a Contamination Assessment will need to be undertaken by a Contamination Assessment Consultant. There is no Aboriginal Cultural Heritage Overlay within the property, as there aren't any named rivers within 100m. There is a Registered Artefact within 100m of the western boundary of the property, if works are planned in this area a Cultural Heritage Desktop Assessment will be needed, to determine what the artefact was and if there is a likelihood of impact to the works. However, works occurring at any other location will not require a Cultural Heritage Management Plan to be undertaken.

Topography: Orientation/shading etc.	Open (mostly) area with close proximity to water storage basin. Land gently sloping towards south which may require benching to be undertaken.	Open, cleared, elevated, northerly aspects available.	Open, cleared, elevated, northerly aspects available.	Open, majority cleared, sloped, northerly aspects available.
Ownership/Control/Interest? Public/private/status Purchase/lease?	Crown land managed by local council (Colac Otway Shire Council) The Colac Otway Shire Council will need to be engaged to discuss the construction of the BESS on land managed by them. As the land is still classified as crown, direct purchase or easement/lease may not be possible, however, a licence could be.	Crown land managed by Colac Otway Shire. Colac Otway Shire will need to be engaged to discuss the construction of the BESS on land managed by them. As the land is still classified as crown, direct purchase or easement/lease may not be possible, however, a licence could be.	Crown reserve for water supply purposes, managed by Barwon Water. Barwon Water will need to be engaged to discuss the construction of the BESS on land managed by them. As the land is still classified as crown, direct purchase or easement/lease may not be possible, however, a licence could be.	Private land owned by Barwon Water. Barwon Water will need to be engaged to discuss the construction of the BESS on land managed by them. Powercor may also need to be engaged if the proposed works encroach into their easements.
Network Access: transformer size/22 kV distance/access	22kV lines on site – High likelihood line constitutes a backbone. To be confirmed in detailed design.	22kV lines c.150m. south of site – High likelihood line is a spur and is unsuitable for the battery arrangement - to be confirmed in detailed design.	22kV lines on site – High likelihood line is a spur and is unsuitable for the battery arrangement - To be confirmed in detailed design	22kV lines on site – High likelihood this line is a spur and is unsuitable for the battery arrangement - to be confirmed in detailed design.

Access/roads/Traffic:	Excellent sealed road access	Excellent sealed road access	Excellent sealed road access	Excellent sealed road access
Overall footprint for technical solution	Available land is 73m wide providing plenty of room for footprint. Land does gently slope toward south which may require benching to be undertaken	Would support co-located solar PV array	Limited space for co-generation	Limited space for co-generation

Figure 5 - Site 1: Barham River streamside reserve, adjoining Barwon Water's Apollo Bay Basin (Barham River Road)

Figure 6 - Site 2: Colac Otway Shire former Marengo Landfill (Roberts Road), Marengo

Figure 7 - Site 3: Barwon Water Marengo Basin (Ferrier Drive) - Marengo

Figure 8 – Site 4: Barwon Water Apollo Bay Water Reclamation Plant - (Montrose Avenue) Apollo Bay

8.5 Appendix E: Features of an Advanced Microgrid

8.5.1. Central solar generation

Central solar system is a ground-mount fixed-axis solar system. While ground-mount solar in the central system requires higher capital and significant space, it has minimal impact on the community and relatively low operating and maintenance costs. It provides a renewable and clean source of local energy for operations.

8.5.2. Wind

Wind can be considered as an alternative, or compliment to central solar generation and may reduce the need for additional storage, however, represents a higher cost and construction time when compared to solar.

The generation profile of wind greatly reduces the storage requirements for achieving 100% renewable targets that rely on PV and storage only. Although this would also be very beneficial as a source of energy in an islanded network, due to the remote nature of wind installations there is a chance any wind installation won't be included in the islanded network backup area.

8.5.3. Generator backup

Generator sets are fully dispatchable and can deliver reliable energy when renewable sources are offline or producing at less than required capacity, or when battery storage is low. They offer high power density, the ability to follow loads, and provide inertia into the microgrid system that can help with the operation of network safety and protection systems.

In order to supply the community during longer outages (>2hours), backup generation would be required. Additionally, this can also support shorter outages (<2hours) where the battery charge is in a reduced state due to operating commercially or providing network support.

8.5.3.1. Diesel

Diesel generation represents a mature and cost-effective technology that would be relatively easy to deploy. This report acknowledges, however, that this solution may not be in line with the community's 100% renewable aspirations. However, as the price of batteries and other potential solutions such as hydrogen storage reduce, or as more solar PV systems are incorporated into the community, diesel generation could be scaled back and retired over time.

8.5.3.2. Hydrogen

Hydrogen generators would represent a clean alternative to diesel generation and would be compatible with a 100% renewable ambition for the community where green hydrogen is used. The technology, however, is in its infancy and is not commercially viable at this point. As costs are reduced and the technology matures, hydrogen backup generators could replace diesel generators over time.

8.5.4. Central System Control

The expected operation is that the solar panels will charge the batteries to ensure they have the minimum required capacity. During an upstream outage, the microgrid will disconnect from the rest of the network and form an island, the batteries will then supply the microgrid for the duration of the outage, ensuring customers in town have access to electricity. If the outage is for an extended duration, such as in the case of an emergency like bushfires, the generator will kick in to supply additional power to the microgrid and other components in the microgrid will orchestrate to ensure electricity for as long as possible. Supplied customers will be able to use energy as normal for multi-day periods, with the exact duration depending on the available energy storage and generation. The duration can also be extended if customers reduce their energy usage or if sufficient demand management is in place.

As such, locations with an Advanced-Grid Connected Microgrid will supply electricity for a sustained period if disconnected from Powercor's Distribution network. Ideally, after the grid power is back, Powercor is able to reconnect the microgrid back to the distribution network to run as normal.

8.5.5. Microgrid Platform

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

The Ubi platform acts as the brain of microgrid integration to ensure all controlled power systems within the microgrid are orchestrated in a safe and efficient manner. Four major inputs are proposed to feed into the microgrid platform, including energy market signals, Distributed Network Service Provider (DNSP) Supervisory Control and Data Acquisition (SCADA) signals, weather forecast and major network events. Based on a comprehensive analysis of received information, the platform aligns to a pre-programmed operation mode at a microgrid level, then decomposes the task to a lower individual power system level via the Ubi device.

The entire control system operates dynamically via constantly collecting real time data from both inputs and individual power systems through the Ubi device within the microgrid. System alarms are triggered if critical measurements are close to or are over safe operating ranges of the current mode. The system then switches automatically into another designed mode or can be manually switched through human intervention to ensure reliable power supply. Over time the logic of the Mondo platform will be enhanced and evolve to better manage microgrid assets in the locations.

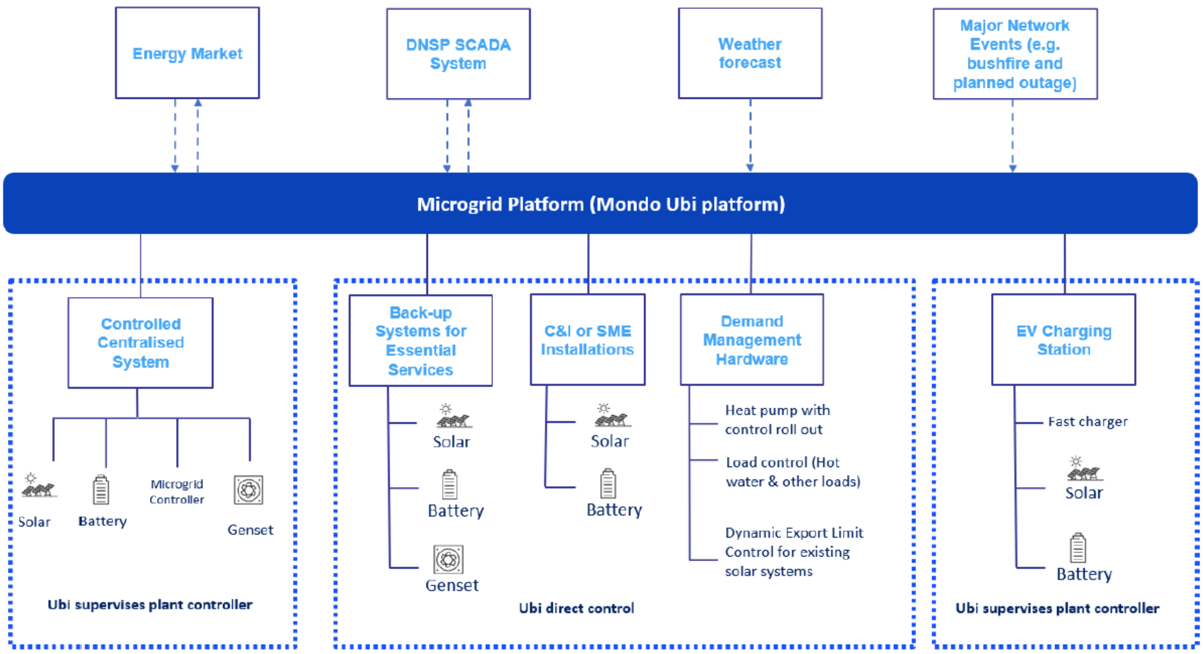

Figure 9 - Microgrid High Level Control Diagram Example

8.5.6. Essential Services Systems

An electricity power backup system for essential services is proposed to further increase community resilience during extreme weather events. The advanced microgrid won't be available during a network outage when the outage duration has exceeded the supply capacity of the central system or there is a network fault within the microgrid supply area that cannot be isolated. Therefore, it is critical to install a power backup system for essential services such as community centres, service stations, and first responder stations, enabling them to continue their respective missions.

Each back up system for essential services includes behind the meter solar panels, a battery and a diesel generator and power inverters with islanding capability. This configuration enables the system to contribute to network demand management in grid connected mode; and hold the supply to critical load of the sites during sustained outages. The sites will be initially selected by considering the nature of their services and a detailed site assessment for each location should be further explored in the community engagement phase. Initial consultation will be conducted with potential site owners to gauge owner interest and ensure there aren't any obvious barriers to implementation.

8.5.7. Business Solar & Storage Systems

Similar to essential services backup systems, solar and battery solutions are designed for medium and large businesses to provide an uninterruptible power supply (UPS) during network outages. These sites are selected to be able to act as hubs for larger amounts of people if necessary and include sites such as colleges. Potential sites are identified, and initial contact can be made in order to determine whether they would be open to accepting a battery backup system.

8.5.8. Electric Vehicle Charging Stations

Electric Vehicles (EVs) will be a major feature in Australia's emission reduction roadmap. Public EV charging stations have been considered as critical infrastructure for future sustainable societies. Therefore, this feasibility study includes EV charging stations as an option to investigate within the design, not only to benefit EV owners but also to actively manage the EV charging as a network demand management solution. The inclusion of EV charging stations also increases community resilience by providing an additional source of fuel for community vehicles that are not reliant on gasoline or diesel fuels. The energy storage built within the EV charging station can not only stabilise highly fluctuated demand due to charging but also has the potential to support local electricity networks during an emergency event.

8.5.9. Demand Management

There are many benefits in having residential demand management including enhancing network stability, prolonging microgrid islanding time during sustained network outages, as well as reducing customers' energy costs during business-as-usual times. To deliver those benefits, a number of demand management solutions have been proposed in this study. Demand management is expected to achieve the following outcomes through the use of a device such as Mondo's Ubi (installed at each customer's premises) for orchestration:

- Reduce peak demand: When the customer's residential controller receives a high demand signal from the microgrid platform, it will reduce customer load such as hot water systems and air conditioners via pre-programmed DRED control logic according to Australian Standard 4755 or contactor control;
- Mitigate reverse power flow: in islanding mode, the microgrid central system must shutdown if total microgrid demand is too much below zero (also known as the sign of reverse power flow) when all batteries are fully charged;
- Load control (increase load): turn on a customer's load such as a heat pump or hot water system when the microgrid load is close to its minimum demand limit;
- Load shift: schedule heat pump or hot water systems to operate in the middle of the day to harvest rich residential solar generation; and
- Dynamic solar curtailment: as residential solar is the only source of reverse power flow, curtail residential solar export via the customer's residential control device to reduce the reverse power flow.

In order to utilise demand management, customers need to be engaged and there needs to be an agreement made that outlines the permissions and extent of demand management at each site. This is particularly important to better understand the customer's situation such as expectation on usage and whether there are any vulnerable people on site that need to be considered. In addition to the above, further demand management can be implemented by contacting large energy users in town to enter agreements that reduce their operations upon request to reduce the town load when necessary.

Examples of demand management proposed can include the following:

- Replacing electric hot water systems with heat pumps to reduce peak load and provide load control;
- Installing variable solar curtailment on existing solar systems to reduce peak solar output with a preference for sites with larger installed solar systems; and
- Installing additional load control where suitable to supplement solar curtailment.

Customers who participate in a demand management program will be able to opt in/out through the project's community engagement phase, however, this will be regulated by terms and conditions in the participation agreement. Installing load bank in central system is another way to manage reverse potential power flow – due to increased PV uptake - during islanding mode if there is not enough distributed customer demand management system recruited. This is not preferred due to the lack of additional benefits of installing a load bank, it does allow the system to operate, however, the underlying excess energy issue isn't resolved, any excess energy in the network will be wasted, and an available function of the microgrid controller isn't utilised to its full potential.

8.5.10. Residential Solar and Storage System

For customers who are outside of an advanced grid-connected microgrid, this solution offers solar plus a battery system with islanding capability to keep customers on supply during network outages. Interested customers can express their interests during the community engagement process. Sites could be identified based on submitted EOIs and be subject to site conditions such as roof conditions and shading. This option is not available to customers within an advanced microgrid as their network is more resilient with central system installed.

8.6 Appendix F: Community Engagement

8.6.1. Key Stakeholders

A list of key stakeholders is provided below.

Table 17 - Key Stakeholders

Stakeholder
Colac Otway Shire
Apollo Bay Chamber of Commerce
Powercor
Southern Otways Sustainable
Great Ocean Road Health
Barwon Water
DELWP

8.6.2. Community objectives

The primary aim of the initial round of community engagement was to ascertain the most important issues to the community that were to be addressed by the technical solution, from both a residential and business perspective. The survey was also designed to identify priority areas for outage protection and gather relevant demographic information, such as residential solar ownership. A QR code linking to the online survey was distributed via direct mail to 1083 post boxes and also conducted face to face at a number of community market stalls. The survey was divided into two parts – one aimed at residents, and the other at local businesses.

With regards to priority areas during a significant outage, those identified by S.O.S were backed up by the results of the engagement:

- 'Emergency services': (likely to be dictated by emergency authorities) but likely to include, the Hospital including the Ambulance Station, CFA headquarters, Telecommunication services, Barwon Water, Police;
- 'Essential services': Refuge centres (AB SLSC, Senior Citizens Hall, AB P-12 College);
- 'People Services': Supermarkets, Petrol Station.

With regards to the demographic makeup of the respondents, a high proportion of respondents have solar, live locally, own their places of residence, are older rather than younger and think achieving 100% renewable is important. This study notes that there are likely to be some data correlations between these variables to consider. Those that had solar think solar exports are important.

Even though it was prompted in the question, 44/80 responses (55%) nominated outages as a challenge/issue but with a heavy proportion noting this as an annoyance rather than serious (with notable exceptions such as the commentary around home-based medical equipment).

The businesses identified as key during a bushfire/extended outages were emergency/ essential services and supermarkets. Someone noted the hospital already has existing back-up. Interestingly, petrol stations came up high on the list. This is useful if targeting any funding for Behind-the-Meter business systems.

In terms of priorities for a neighbourhood battery, "reliability" and "100% renewable" were identified as more important than "resilience" with "increased capacity for solar" an obvious last priority.

Table 18 below summarises the responses gathered during market stall engagements and were consistent with the results from the online surveys.

Table 18 - Community's (residents') feedback from four market engagements as at 1 March 2022 (142 separate engagements)

TOTALS

	Resilience		**Reliability**		**Grid Capacity**		**100% renewable**	
Preferences	**Votes**	**Points**	**Votes**	**Points**	**Votes**	**Points**	**Votes**	**Points**
First (4 points)	**19**	**76**	**37**	**148**	**6**	**24**	**78**	**312**
Second (3 points)	**51**	**153**	**36**	**108**	**25**	**75**	**24**	**72**
Third (2 points)	**39**	**78**	**46**	**92**	**31**	**62**	**27**	**54**
Fourth (1 point)	**22**	**22**	**28**	**28**	**80**	**80**	**14**	**14**
Total Points		**329**		**376**		**241**		**452**

The responses from the local business community were similar to the responses from the residential community, with the key difference being that businesses were more likely to rate reliability as the most important issue, with 100% renewable ambitions as a close second.

Table 19 - Community's (Business) feedback from online survey 22 April 2022

TOTALS

	Resilience		**Reliability**		**Grid Capacity**		**100% renewable**	
Preferences	**Votes**	**Points**	**Votes**	**Points**	**Votes**	**Points**	**Votes**	**Points**
First (4 points)	11	76	19	44	5	20	19	76
Second (3 points)	16	39	13	48	15	45	12	36
Third (2 points)	14	22	11	28	19	38	11	22
Fourth (1 point)	12	13	13	12	14	14	14	14
Total Points		**132**		**150**		**117**		**148**

8.6.3. Ownership Structure

The primary aim of the second round of community engagement was to test community appetite for the different ownership structures associated with a neighbourhood battery.

The three ownership models outlined in section 6.2 were posed to the community, with the risks and benefits clearly laid out for each model. The community was asked to vote for the ownership model they preferred

The results were as follows:

Table 20 - Community feedback on ownership structure

Votes Market Stall

	Market Stall		Online Engagement	
Ownership Structure	**Votes**	**%**	**Votes**	**%**
Third-Party owned	13	68%	14	35%
Joint-Venture	4	21%	14	35%
Community Owned	2	10%	12	30%

Also included in the responses for the ownership models was the following qualitative feedback:

Third-party owned – The feedback on this model was that the community would need a water-tight agreement with the 3rd party that the battery would provide for the community in the areas required and that a reserve would always be left in the battery (it would never be fully drained by the 3rd party) to cover for unplanned outages.

Community Owned - Both voters conceded this option would only be possible if the community didn't have to pay for the battery. They were very vague about who in town had the smarts to operate and maintain the battery, but the sentiment could be summed up as "we'll be right".

Joint Venture - The vendor contracts should include an option at the 5-year mark where the community can buy out the vendor. At this point we (the community) will likely understand what we are capable of. This would need to include items to ensure the vendor could not gouge us such as:

- Independent valuation of the vendors part;
- Payment options e.g. once off or over time;

Identification of any ongoing costs e.g. they will likely have cloud services for network management and reporting etc.

8.6.4. Town Hall

Once the feasibility study stage has concluded, Mondo will act as technical support assisting S.O.S. for the planned Town Hall or community forum. The purpose of which is to provide an opportunity to engage with the community and act as a knowledge sharing opportunity for the outcome of the proposal at the heart of the feasibility study. The session should also aim to cover questions raised by the community and informally gather community sentiment and feedback on progress to date.

8.7 Appendix G: Accessible value streams from a Big Battery

Within the set of wholesale revenue streams, there are two key markets: “energy” and “frequency”. Energy represents the commodity of electricity described earlier and is represented in the same way as electrical energy on a customer bill (though in much larger units of measure), in ‘dollars per Megawatt-hour’ or $/MWh. In addition, there is a separate market for frequency – in Australia the power system frequency is set at 50 cycles per second (50Hz) and is governed by strict technical standards to maintain this at all times. To encourage participants to play their part, the market has a mechanism to reward market players for frequency stabilisation in the form of a price signal.

Aside from the wholesale market revenue streams, the remainder of the value stack is made up of customer bill savings, reduced DNSP maintenance and upgrade costs and potential off-market agreements with third parties. This is summarised via the example below and outlined in detail in the subsequent section.

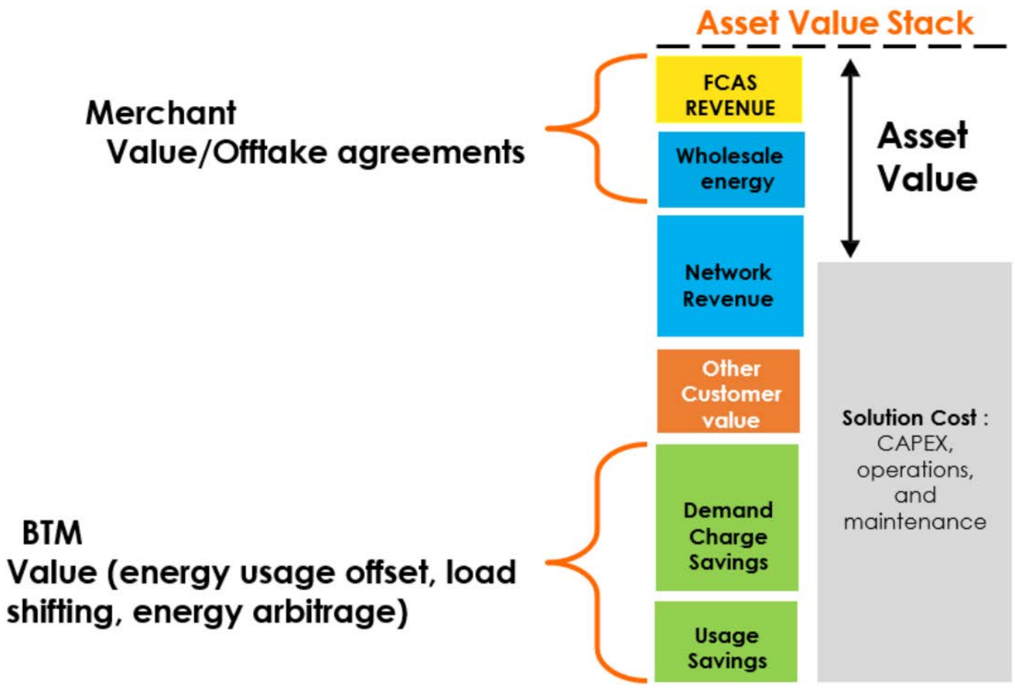

Figure 10 - Asset Value Stack for BESS

8.7.1. Merchant energy

Excess energy from the storage solution can be sold on the NEM. It is expected that excess energy will exist at various times of the day and throughout the year, for example in daylight hours when customers cannot use all of their solar energy. This will then flow into the storage, where there will remain a shortage of takers for this energy during the day. The excess energy can either go to non-solar customers or the grid – the latter giving rise to participation on the wholesale market.

Typical average prices in the Victorian pool of the NEM were around $46/MWh in 2021 or around 4.6c/kWh[15]. For reference, a typical customer bill is about 20-25c/kWh for the usage component.

[15] AEMO NEM Data Dashboard

8.7.2. Merchant (FCAS)

Essentially, the system frequency is balanced by quickly increasing or decreasing power output (measured in Megawatts). The price signal described earlier applies a dollar value to each chunk of power that is increased and/or decreased rapidly and is measured in 'dollars per Megawatt of change' or $/MW. It is important to recognise the difference between the energy ($/MWh) and the frequency ($/MW) markets and units of measure. The frequency market is known as 'Frequency Control and Ancillary Services' (FCAS).

The FCAS market is further segmented into the "contingency" and "regulation" markets, where only the contingency market is considered within the scope of this report. Further, there are six sub-markets within the contingency market but for simplicity, it will only be discussed as the "contingency FCAS market".

Participation in the FCAS market is considered to be a valuable opportunity for the energy solution. In a similar way to energy prices, the Australian Energy Market Operator (AEMO) also publishes FCAS prices on its website, although these are not shown in the 'headline' fashion that energy prices are. From this data, a number of financial analysts formulate forward estimates of what the FCAS price will do (as they do with energy prices). These forward estimates enable Mondo to evaluate the FCAS opportunity for this project.

Capture prices are expected to be within the range of $1/MW to $12/MW.

8.7.3. Offtake agreement

The BESS could also sell electricity to a specific user similar to a Power Purchase Agreement (PPA), where the purchaser (often called the 'offtaker') agrees to buy a percentage of the electricity produced by the asset on an ongoing basis. This arrangement could also work in reverse with the BESS acting as a buyer for a local community solar farm, thereby charging for a reduced cost when compared to the grid. Potential offtakers include large-scale generators and large industrial energy users like Barwon Water.

8.7.4. Network support (voltage and power)

Similar to FCAS (outlined above) as a service that is used to support the network but through voltage, active power, and reactive power control. Agreements are made with the network provider to operate the battery in a certain manner upon their request or when the network experiences certain constraints.

It is worth pointing out that Powercor has recently published (and can be expected to do so in future years) an EOI for such network support services.

8.7.5. Energy usage offset

By storing and re-using excess energy from community solar PV, less energy is bought by Apollo Bay customers from the grid. Not only does this positively contribute to the 100% renewable goals of the community - it also provides a financial benefit. The difference between the cost to serve customers' energy from the battery versus the cost to buy from the grid represents value that can be shared between the battery asset owner and the community. That value sharing mechanism would likely be implemented in the form of a tariff - e.g. a localised network charge.

8.7.6. Load shifting

A centralised battery would allow the community to avoid periods of peak energy prices - typically around the early evening. The battery can either buy from the grid when prices are low, or store energy from excess DER (or a combination of both), and feed back into the community during peak pricing periods.

8.7.7. DER enablement (e.g. solar sponge)

Due to voltage and system strength issues, solar PV export (from businesses and households) can be limited. A battery, or network of batteries would increase the amount of solar that can be exported by the community and allow a higher penetration of DER within the community, reducing the need to buy energy from the grid. DER enablement is strongest on the bus that the battery is connected to. In this case it's the MV with a lowered effect on LV.

8.7.8. Energy arbitrage

The term 'arbitrage' refers to the ability to buy a commodity from one market and sell into another market at a premium within a short space of time, thereby exploiting a mismatch in pricing between those markets. In the case of community energy, arbitrage opportunities are likely to arise intra-day where cheap (and/or free) energy can be obtained during sunlight hours and sold during evening peak times. The battery facilitates this through storage of energy and enabling the time-shifting of energy prices from morning to evening.

Arbitrage is applicable to wholesale trading, retail pricing and network tariffs.

8.8 Appendix H: Business Model

The business model ultimately governs how the storage solution is owned, managed and operated from a commercial perspective. Common examples of business models are joint ventures (JV) and build, own, operate and transfer (BOOT) arrangements.

Whilst there is more than one possible business model, these models will also apportion the costs and benefits of the project. On the cost side, expenditures can broadly be categorised in terms of capital and operating, fixed and variable. On the benefits (or revenue) side, these also apply along with additional categories of revenue, known as “revenue streams”. Revenue streams represent different types of income but importantly, the cost savings of various stakeholders are also considered as revenue streams for the purposes of this project – e.g. bill savings for customers. The collection of these revenue streams is also known as the “value stack”.

Typical revenue streams for these types of projects mirror those of any other commodity market, at a basic level revenue is simply price *x* volume:

- The commodity is produced and sold on a wholesale market where price is dictated by market forces;
- Other commodity sales may be negotiated with a counterparty directly, this is known as “over the counter” (OTC);
- Additional derivative markets may be used to complement physical commodity sales or hedge against various market risks (e.g. currency movements). These derivatives often take the shape of ‘futures’, ‘swap’ or ‘cap’ instruments.

In the case of this project, the commodity is clearly electricity and there is a wholesale market for this product called the National Electricity Market (NEM). If the storage solution is sufficiently large, it will be eligible to participate directly in this market and trade energy at a wholesale level, alongside large coal, wind and gas generators. Clearly there are many other players between the wholesale market and end-customers – for the purposes of this study those key players are the distribution network (DNSP i.e. Powercor) and the retailer (over 20 in Victoria).

In addition to the ownership models, there are a range of business models to consider for the development and operation of an MV battery, these are outlined below.

BOOT – Build, Own, Operate and Transfer

Under this type of engineering contract, a third party would build, own and operate the battery for a set amount of time to recoup costs, following which they would transfer it back to community ownership.

Advantages

- Reduction in risk for the community by outsourcing to a third party;
- Potential to reduce upfront Capex costs;
- Makes the engagement more attractive to a third-party developer.

Disadvantages

- Third party would own and operate the BESS for a period of time;
- Community would have a significantly reduced input for the period of third-party ownership;
- Risk that the third party's costs are not recouped before the end of the asset life.

BOOM – Build, own, operate and Maintain

A third party would build, own, operate and maintain the BESS. This is the model associated with a third-party ownership structure and shares the similar benefits and challenges as a third-party ownership model. The key advantages and challenges are outlined below

Advantages:

- Reduces the risks (for the community) associated with owning and operating the battery;
- Third party is responsible for owning, operating and maintaining the battery.

Disadvantages:

- May be difficult to enact operational changes proposed/implemented;

- Potentially less input into system design and operation;
- A third-party will have expectations of a return on investment.

EPC – Engineering Procurement and Construction

This would accompany all ownership models, however, would lend itself most to a community ownership model. A contractor would be responsible for all related engineering services, the procurement and production of all necessary construction materials and parts, as well as construction and commissioning. At the completion of the project the contractor would hand over the neighbourhood battery to either the community or the third-party owner, depending on the ownership structure.

Advantages

- Simple contract, turnkey product available to the community at the completion of the contract.

Disadvantages

- Higher upfront cost (CAPEX) – would require grant funding or investors;
- If fully owned by community, exposes community to high risk during construction and after completion;
- An 'Owner's Engineer' would be recommended to manage relationship with EPC Contractor.

8.8.1. Third-Party Agreements

Should the community decide on pursuing a third-party owned or operational model once the MV battery has been completed, the following agreements/contracts would service to dictate the revenue streams from the third party

Lease Payments/Annuities

A lease payment or annuities are regular payments, similar to rent, that are formally agreed upon under a contract between the third-party operator and the community, granting the third party the right to use the neighbourhood battery for a specified amount of time. A lease provides the lessee with limited right-to-use without transferring ownership in return for payment to the lessor.

Service Level Agreement

A service level agreement (SLA) in this instance would be an agreement between the community and the third-party vendor. The agreement would dictate the service that the community would expect from the vendor including any penalties should the service not be achieved. For the MV battery the SLA relates to the ownership and maintenance and would, therefore, correspond with a third-party ownership model.

8.8.2. Revenue

The figures below represent a conservative estimate of the potential revenue from the modelled value stack sources. This figure is considered a good estimate of potential revenue from the BESS given the storage capacity. The exact configuration of the value stack may vary depending on the intended use of the BESS, however, this would only represent minimal shifts in overall revenue, as you will be reallocating capacity from one objective to another.

Estimated NPV revenue range from the modelled value stack (arbitrage including spot price volatility & FCAS) for 5MW/10MWh: **$7,400,000.00-$13,700,000.00.**

It should be noted that avoided network augmentation is not a guaranteed revenue stream, and may substitute only some, or none of the quoted.

Other value stack items, such as offtake agreements, have not been included in the economic assessment because of the significant number of associated variables they introduce, without providing more valuable insight into the financial viability of the project. These include, but are not limited to customer bill savings, offtake agreements, and revenue from/generation of green certificates. Decisions involving additional value stack streams, such as negotiating an offtake agreement, can be evaluated in comparison against this “base case” scenario provided to evaluate their value.

It should be noted that this analysis assumes that all of the capacity of the battery is used for revenue generation on the market. If the owner of the asset decides to reserve capacity for alternative use cases, for example the community reserving capacity for local usage, this will impact the revenue streams from energy trading and FCAS participation.

8.8.3. Solution Package Cost Summary

The capital and operating expenditure is estimated in the table below. Mondo is aware of supply chain issues which may mean that the figures quoted below might change significantly due to future price rises.

Table 21 - Project Costs

Item	Cost (CAPEX) range	Cost (OPEX) range (p.a.)
Battery System Cost	$7,400,000.0 - $13,800,000.0	$42,000.0 - $78,000.0
Charging and network Costs		$130,000.0-$240,000.0
Balance of Plant	$1,800,000.0 - $3,400,000.0	$9,000.0 - $16,900.0
Network Connection Cost	$330,000.0 - $440,000.0*	
Project delivery and management costs	$400,000.0 - $600,000.0	
Total with contingency (5%)	**$9,930,000.0 - $18,300,000.0**	**$181,000.0 - $335,000.0**
Required government grant funding (up to 49% of project)	$4,200,000.00-$6,900,000.00	

* Note that this figure assumes the majority of the connection will be allocated as load connection costs by Powercor and would be captured via network charges such as DUOS charges. This number could increase dependant on the decision by the DNSP and may increase to $1-1.5M