Feasibility Report

Neighbourhood Batteries in Nillumbik

June 2022

Clean Energy Nillumbik

wave CONSULTING

Traditional Owners

We would like to respectfully acknowledge the Traditional Custodians of the land, Peoples of Wurundjeri Woi-wurrung Country and pay respect to their Elders past, present and emerging.

Document Management

Version	Date	ID	Authors
1 – Draft	22 April 2022	2021-019-D35	R. Catchlove, Z. Hughes-Miller, A. Carbonell.
2 – Final	10 June 2022	2021-019-D36	R. Catchlove, Z. Hughes-Miller, A. Carbonell.

Disclaimer

This document may not be used for purposes other than those for which it is compiled. While every care has been taken to compile this report, Wave Consulting Australia Pty Ltd accept no liability whatsoever for any loss (including without limitation direct or indirect loss and any loss of profit, data, or economic loss) occasioned to any person nor for any damage, cost, claim, or expense arising from reliance on this report or any of its content.

Acknowledgments

We would also like to acknowledge several Clean Energy Nillumbik, and industry advisors, including:

- Natalie Bucknell (Chair of Clean Energy Nillumbik)
- Daryl Brooke (former Chair of Clean Energy Nillumbik)
- Mark Stacey (volunteer at Clean Energy Nillumbik)
- Roger Brown (volunteer at Clean Energy Nillumbik)
- Marnie Shaw (Battery Storage and Grid Integration Program at the Australian National University)
- Chris Wallin (Yarra Energy Foundation)
- Benjy Lee (Benjy Lee Consulting)
- Ian Culbard (Nillumbik Shire Council)
- Seamus Balkin (Nillumbik Shire Council)
- Gary Hocking (AusNet Services)
- Siri Sao (AusNet Services)
- Nick Withers (volunteer at Clean Energy Nillumbik)
- Kira Lee (associate of Benjy Lee Consulting) for the Word Cloud

We formally acknowledge our subconsultants, Benjy Lee Consulting and Yarra Energy Foundation, for their contribution to the report as well.

Citation

Wave Consulting Australia, 2022. Final Feasibility Report for NBI Project. A report for Clean Energy Nillumbik.

Cover image

Battery and leaf image. Source: Shutterstock image library, licenced for use by Clean Energy Nillumbik.

Table of Contents

Glossary

AC Alternating Current

AEMO Australian Energy Market Operator

AER Australian Energy Regulator

AESA Australian Energy Storage Alliance

ARENA Australian Renewable Energy Agency

CAES Compressed Air Energy Storage

CAPEX Capital Expenditure

CEC Clean Energy Council

CSIRO Commonwealth Scientific and Industrial Research Organisation

DC Direct Current

DER Distributed Energy Resources

DM Demand Management

DMEGCIS Demand Management and Embedded Generation Connection Incentive Scheme

DMIA Demand Management Innovation Allowance

DMIS Demand Management Incentive Scheme

DNSP Distribution Network Service Provider

DSP Demand Side Participation

EPRI Electric Power Research Institute

EV Electric Vehicle

FCAS Frequency Control Ancillary Services

GJ Giga-Joule

GUSS Grid Utility Support Systems

GW Giga-Watts

HVAC Heating, Ventilating and Air Conditioning

IP Intellectual Property

IT Information Technology

LCOE Levelised Cost of Energy

LUOS Local use of system charge

Li-ion Lithium-ion

MW Mega-Watts

MWh Mega-Watt-hours

NCAS Network Control Ancillary Services

NEM National Electricity Market

NMI National Metering Identifier

NSP Network Service Provider

OPEX Operating Expense

PPA Power Purchase Agreement

PV Photovoltaic

RE Renewable Energy

RFP Request For Proposal

RIT-D Regulatory Investment Test for Distribution

T&D Transmission and Distribution

TNSP Transmission Network Service Provider

TOU Time of Use

UPS Uninterruptible Power Supply

Executive Summary

Clean Energy Nillumbik (CEN) applied to the Neighbourhood Battery Initiative to explore the feasibility of neighbourhood batteries at three specific sites within the Nillumbik Shire local government area. This report outlines the findings from the feasibility study of neighbourhood batteries at three sites; two in Eltham and one in Research. Eltham and Research are approximately 20 kilometres from the Melbourne CBD and are all located in the AusNet Services electricity distribution zone.

The key question this study is focused on is, "Is it technically and financially feasible to locate a neighbourhood battery, owned and used by the community, in Nillumbik, in areas with relatively high solar installations, and who would benefit from this model?"

The feasibility project was completed over a nine-month period between 2021 and 2022. The project was split into five stages, and due to the nature of this investigation there was significant overlap between all of the stages. These stages were: Stage 1 – review of past projects and community engagement planning, Stage 2 – site analysis and community engagement, Stage 3 – technical feasibility and sizing, Stage 4 – ownership options, and Stage 5 – reporting.

Community engagement and community support for the proposition of a neighbourhood battery were critical to this project. From a community perspective, the project has identified that:

- 81% of community were 'very interested' or 'interested' in buying and selling energy from a neighbourhood battery
- 90% of attendees at the 'street corner' discussions were very supportive of the concept
- 57% of community thought that batteries on their street were 'very suitable' or 'suitable', and 78% thought that batteries in their suburb were 'very suitable' or 'suitable'
- 42% of the community would be willing to pay up to $2 / day for a neighbourhood battery
- From this project there is now a collaborative group of 20 residents across Nillumbik that are interesting in being 'community champions' of neighbourhood batteries.

The sites of interest were designated by AusNet Services, and all included approximately 90 to 120 NMI connections, in mostly residential areas.

Modelling of the power system and economic scenarios were completed over a 12.5-year period. They revealed that for these three zones, batteries would be between 180 kWh and 280 kWh in size. Forecast revenue from these assets revealed potential revenue from wholesale prices, FCAS markets, and network revenue of up to $180,000 and $300,000 respectively, over their forecast life of 12.5 years.

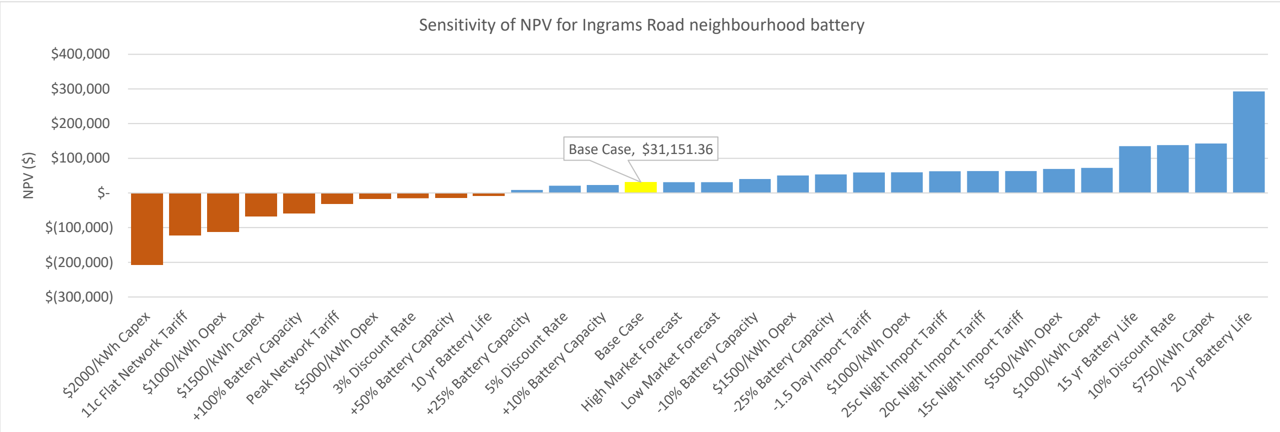
The feasibility study assumes that a 'community battery tariff' will be applied (despite not currently existing within AusNet Services tariff structure statement) and assumes that this is one of the revenue streams a battery will benefit from. A community battery tariff is a tariff being trialled in other DNSP areas of Victoria, that is structured to incentivise charging of an infront of the meter battery in the daytime, and discharging at night. Additional engagement and advocacy work is required to work with AusNet Services to set up a trial of this tariff structure, in Nillumbik (with detail in the body of the report outlining what is required to move towards this type of tariff).

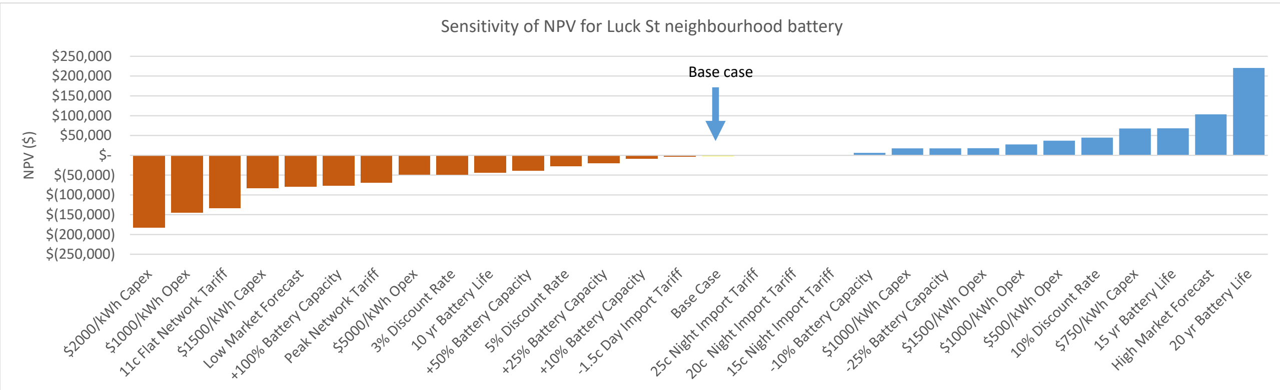
Neighbourhood batteries are feasible at two of three locations analysed in this study in Nillumbik based on the financial modelling. The assumed total capital required to cover the cost of these two batteries is $510,000 based on industry estimates of these types of batteries in similar locations.

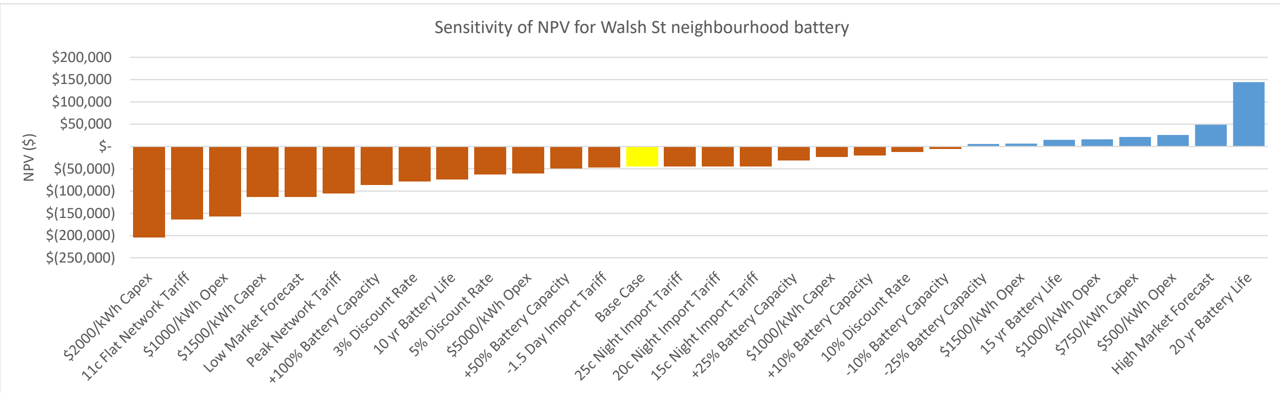
Ideally CEN would seek $750,000 of grant or seed funding to set up a new entity and deliver these two batteries. This would enable all stakeholders to develop a working model, and then future projects would seek community investment.

The feasibility is heavily influenced by some key factors and parameters, such as the cost of the batteries, the operating cost of the battery, the life cycle of the battery, network tariffs, and forecast revenues. The financial feasibility can be improved through additional work to a) reduce the cost of the battery, b) reduce the administration and ongoing costs each year, c) increase the size of the battery, d) consider opportunities to deliver network services and generate revenue from this and e) increase the life of the battery. The last point on battery life makes a significant improvement to the NPV for all three locations.

The Net Present Values of two of the most feasible sites are between $0 and $35,000 over a 12.5-year period. On the basis that the analysis is quite conservative, and there may be other revenue streams in the future, two of the three locations were deemed suitable to proceed with. All sites would not be feasible if there was not a new 'Community Battery Tariff' in place, as the NPV drops by between $40,000 and $120,000. The results from the NPV sensitivity analysis for all three batteries is shown below.







The community engagement has indicated there is significant support for these projects, and beyond the current proposal the community in fact have explicitly stated they want these neighbourhood batteries to do more than just energy arbitrage and FCAS trading, and ideally want to see these batteries to support grid back up and islanding of these small LV networks.

The community are interested in owning or using the neighbourhood batteries on the basis that they are part of an integrated approach to smarter energy use, allow for an increase in the generation of more locally produced renewable energy, support the adoption of more electric vehicles, and a move to zero emissions communities and economies.

There are several ownership options that vary in complexity and also in terms of the long-term potential to administer and support community ownership of these assets. This project has recommended a managed investment scheme to enable community and investor ownership, and to avoid the need for a new company for each individual battery.

The specific local voltage networks sites investigated in this study have a range of issues, but on the whole meet the main criteria as appropriate sites for neighbourhood batteries. The key barrier to overcome is the land ownership and associated leasing arrangements at each site.

The feasibility study has been affected by the ability to get timely access to data, particularly DNSP related datasets. This is an issue the industry is addressing and needs to continue to work on to more efficiently assess the feasibility of neighbourhood batteries.

The role of the DNSP and Council in this process is critical, as is access to good data and electricity market data. The process of feasibility studies could be significantly improved through timely access to data, and increased resourcing within the DNSP and Council to engage and respond to issues as they arise. If these stakeholders made a financial contribution to the feasibility study, it is assumed they would be more likely to support and assist the project.

The feasibility study outlines a pathway and series of next steps, including in order of priority:

1. Review the feasibility report.
2. CEN to discuss governance structure.
3. Confirm future community battery tariff structure.
4. Confirm and review detailed cost estimates, based on AusNet Services advice on connection requirements and background studies required.
5. Review other sites to ensure these battery locations are the best in the region.
6. Confirm site location with landowners and obtain lease agreements.
7. Confirm connection arrangements.
8. Seek grant funding and consider options for grant applications to de-risk the venture.
9. EOI with energy retailers.
10. EOI for the community.
11. Contract with energy retailers.
12. Capital raise.
13. Commencement of tendering and construction process.

1 Introduction & background

1.1 Background

The Neighbourhood Battery Initiative (NBI) provides funding to support communities assess the feasibility of neighbourhood batteries, and in some instances support the implementation of neighbourhood batteries. It is a grant administered and funded by the Victorian Government Department of Environment, Land, Water and Planning (DEWLP). DELWP have funded 13 feasibility studies, and CEN is a recipient of one of these feasibility study funding grants.

Clean Energy Nillumbik (CEN) is a volunteer community group with a vision to have 100% of Nillumbik's buildings powered by renewable energy by 2028. They have been active in the community and supported a range of bulk buys, festivals, sustainable home open days, and feasibility studies such as this and the option for a community owned solar farm in the region.

Clean Energy Nillumbik (CEN) applied to the Neighbourhood Battery Initiative to explore the feasibility of neighbourhood batteries at three specific sites within the Nillumbik Shire local government area. This report outlines the findings from the feasibility study of neighbourhood batteries at three sites; two in Eltham and one in Research.

The key question this study is answering is:

> "Is it technically and financially feasible to locate a neighbourhood battery, owned and used by the community, in Nillumbik, in areas with relatively high solar installations, and who would benefit from this model?"

1.2 What is a neighbourhood battery?

A neighbourhood battery, by definition, is an asset that is located in front of the meter and could be on private or public land. It is an energy storage asset designed to charge and discharge electricity, support a more resilient grid, and increase the number of solar connections in the neighbourhood and store locally generated solar power for use at night.

A conceptual diagram of a neighbourhood battery is shown below in Figure 1.

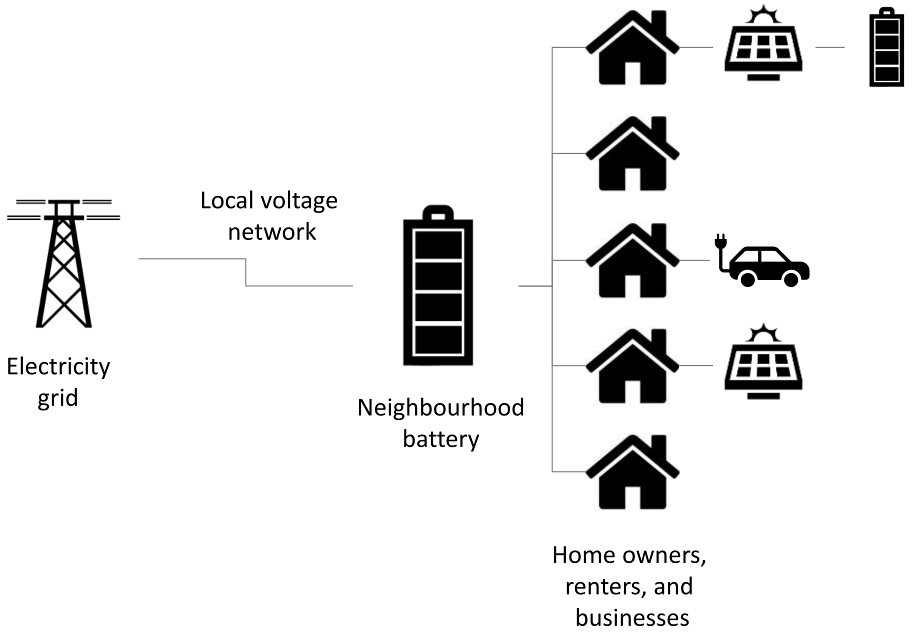


Figure 1. Conceptual diagram of a neighbourhood battery in a local community (Source: Wave Consulting Australia).

1.3 Objectives

The objectives of this report are to investigate the range of issues that will impact on the feasibility of designing, installing, and operating a neighbourhood battery within Nillumbik.

The objective is to explore the issues associated with:

- Site location
- Community acceptance and support
- Connection with local voltage network
- Costs and benefits
- Ownership models
- Financial feasibility

This report includes a summary of the main findings from a technical feasibility, town planning and community engagement perspective, and then recommends the next steps to be taken by Clean Energy Nillumbik to install the battery and operate these assets.

1.4 The study area

Three locations within the Nillumbik local government area (LGA) were identified by the Distribution Network Service Provider (DNSP), which in this area this is AusNet Services, based on relatively high level of solar penetration observed at these sites relative to the rest of Nillumbik, and where a neighbourhood battery would be compatible with the network.

The three locations are at Luck Street (Eltham), Ingrams Road (Research), and Walsh Street (Eltham), and are shown below in Figure 2and Figure 3.

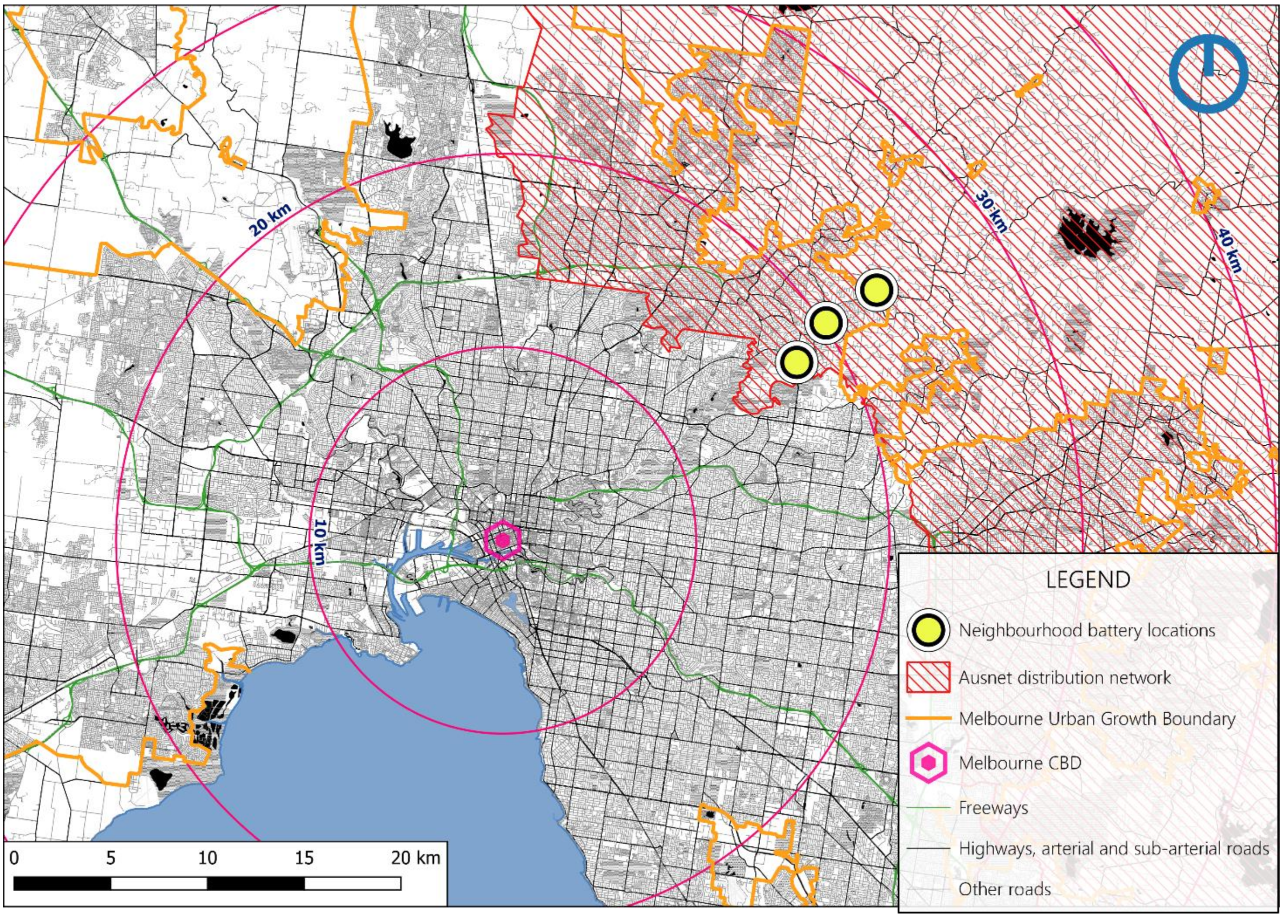


Figure 2. Neighbourhood battery locations considered within Nillumbik LGA.

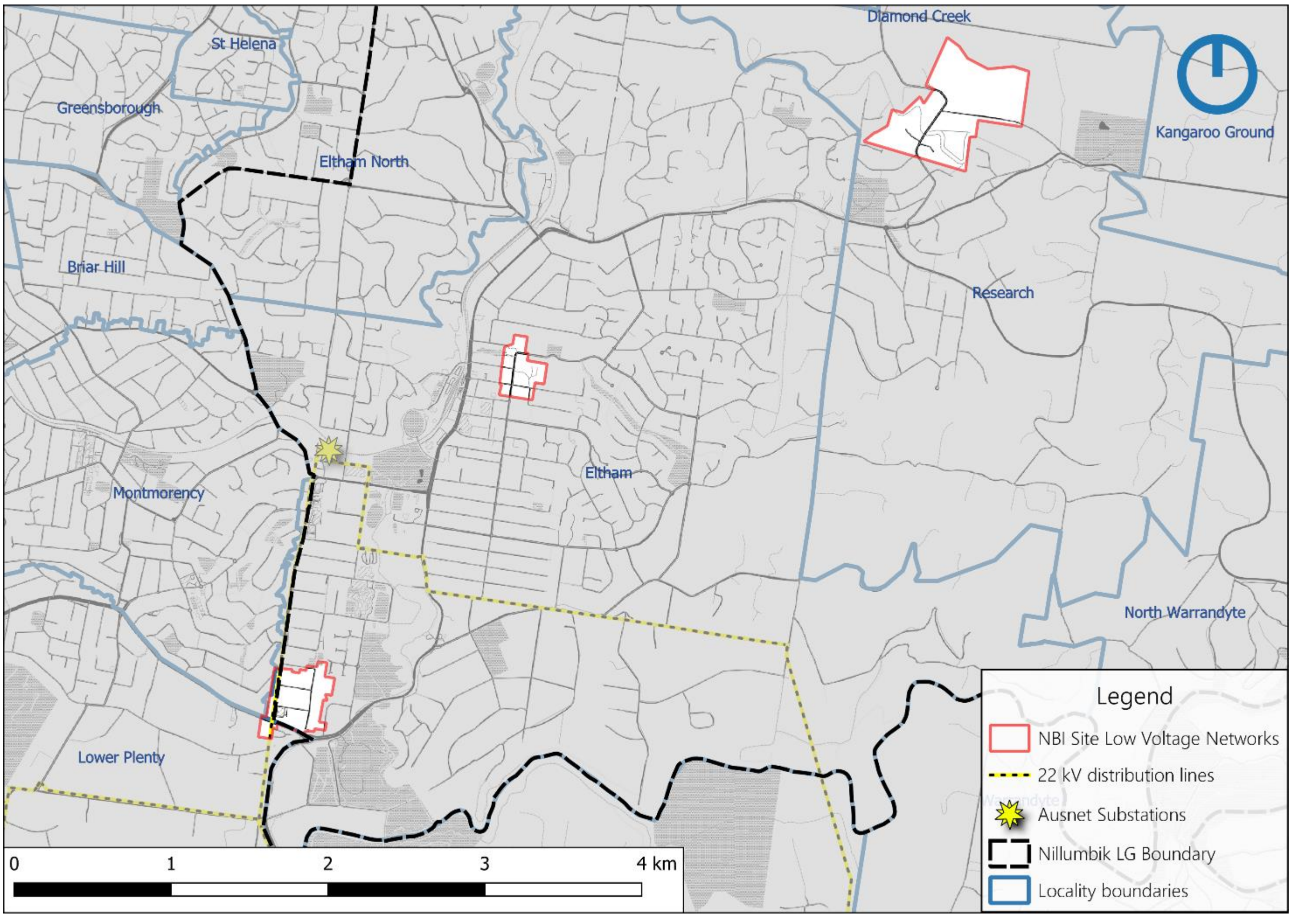


Figure 3. Local voltage networks around the three locations of interest.

Note that no other sites were investigated within Nillumbik for this study, on the basis that these were considered to be pilot sites, and others will be identified in the future and delivered using the insights and process that this project has defined.

2 Method and process

The feasibility project was completed over a nine-month period between 2021 and 2022. The project was split into five stages, and due to the nature of this investigation there was significant overlap between all of the stages.

The grant required a series of deliverables against each of the five milestones, and these broadly line up with the stages below.

2.1 Stages

Stage 1 – review of past projects and community engagement planning. In this stage of the project the project team set up the governance of the project, reviewed past projects and developed a comprehensive community engagement plan.

Stage 2 – site analysis and community engagement. In this stage the team looked in detail at the three locations and commenced the community engagement, that continued throughout the whole project.

Stage 3 – technical feasibility and sizing. In this stage the modelling of household and small business electricity demand was undertaken, alongside solar generation, battery sizing, battery cycling and FCAS supply.

Stage 4 – ownership options. In this stage the team worked through the various ownership and operation models. In Stage 1 a review of other projects identified the ownership models that other neighbourhood batteries have adopted. In particular Yarra Energy Foundation have explored these issues, with reference to the fact that there are asset owners, landowners, operators, and retail aggregators involved in an asset like this. All key stakeholders in this project were engaged to explore opportunities for all of them to play a role in this ownership and operation aspect of neighbourhood batteries.

Stage 5 – reporting. In this stage all of the above stages were collated into a single 'feasibility report' (this report). It should be noted at the completion of all of the above stages there were interim reports drafted and submitted to meet milestones under the grant contract. Engagement with stakeholder and community were finalised in this stage, noting that ideally this engagement will continue beyond the feasibility report period.

2.2 Community engagement methods

Community engagement (commenced in Stage 1 and continued through to Stage 5) was a large part of this feasibility study. The engagement process included the following initiatives:

1. Newsletters and news updates
2. Online survey
3. Online social media threads (general)
4. Online social media threads (Eltham)
5. Online social media threads (Research)
6. Eltham Farmers' Market engagement
7. Letter drops to specific neighbourhoods
8. Online info sessions (x4)
9. Street conversations (x3)
10. Focus group – face to face or online
11. Community update – what we heard

Information and updates were shared through Nillumbik Shire Council's community channels, as well as Clean Energy Nillumbik's Facebook page.

Figure 4. Example flyer used as part of the community engagement process.

The core purpose of the engagement was to understand the willingness, interest, and level of support (as either a buyer, seller, or investor) for a neighbourhood battery in Nillumbik.

The aim of the engagement was to provide empirical evidence as to support, the location, and value, and willingness to pay for a battery in a specific local location.

Engagement with the two main stakeholders (AusNet Services and Nillumbik Shire Council) was conducted in addition to the community engagement tasks.

Community engagement was always led by Clean Energy Nillumbik, who had credibility, contacts, networks and existing links and relationships with the community, ensuring that the community immediately started with a more open and trusting outlook to the engagement.

2.3 Data requirements and data availability

Data is critical to assessing the feasibility of neighbourhood batteries. Data to undertake these types of feasibility studies (in particular being “in front of the meter”) comes from various sources, and the DNSP holds a lot of critical data that supports the development of a feasibility study as they have monitoring data on power flows and network operations.

Table 1 below lists the various datasets used in this project, and their corresponding availability. In all instances several efforts were made to gain access and approval for use of each dataset.

The supply and access to data is a complex issue, and while ‘in principle’ support was obtained in the grant application process from the key stakeholders with most of the data, unless there is a financial interest and clear impact for the stakeholders involved and directly linked to this project, then there is little to no incentive to ensure data is supplied in a timely manner, or at all.

Table 1. List of data requirements and availability

Type	Description	Spatial and temporal detailed	Source	Supplied for this feasibility study
Electricity (assets)	Substation transformer specification	Specific poles	DNSP	Yes
Electricity (assets)	Total solar capacity installed	NA	DNSP	Yes
Electricity (assets)	Total number of customers within LV network	Property addresses	DNSP	Yes
Electricity (assets)	Capacity of LV network and connection points	Specific poles	DNSP	Yes
Electricity (metered)	Aggregated electricity loads at the local substation transformer	Maximum 30-minute intervals	DNSP	Yes
Electricity (metered)	Aggregated electricity exports of locally generated solar power at the local substation transformer	Maximum 30-minute intervals	DNSP	No
Electricity (tariffs)	Current tariffs of customers	AusNet region	DNSP	Yes
Electricity (tariffs)	Local use of system tariff	Nillumbik region	DNSP	No
Property / land	Spatial network of LV network	Specific Eltham / Research properties	DNSP	Yes
Property / land	Land ownership	Specific Eltham / Research properties	Council	Partly
Planning	State and local planning zones and overlays	Specific Eltham / Research properties	Council	Yes (publicly available)
Solar exposure	Historical data on irradiance	Eltham station	BOM	Yes (publicly available)
Financial	Cost of installation	Up to 500 kWh	Industry	Yes (publicly available)
Financial	Operating cost	NA	Industry	Yes (publicly available)
Financial	Life cycle	NA	Industry	Yes (publicly available)

Where data was not available, estimates were made to use in this feasibility instead. For example models of solar generation based on local data from a Bureau of Meteorology Eltham irradiance monitoring station (listed above in this table), was used as a substitute for metered solar exports.

2.4 Technical modelling

Modelling was undertaken of the network electricity power system flows, and aggregated household electricity usage and solar generation, solar exports within each of the three local voltage networks and associated economic modelling to inform the feasibility of a neighbourhood battery. Figure 5 below shows the conceptual aggregated power flows with a neighbourhood battery.

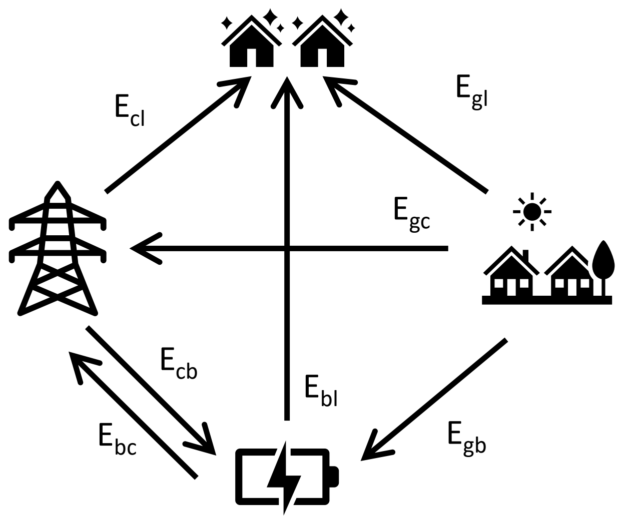


Figure 5. Power flows in Nillumbik with a community battery. As Figure 1 but also includes battery charging and discharging (both to homes and the grid) (Source: ANU, 2020).

The power flows as noted in Figure 5 are as follows:

- E_{cl} where power flows from the connection point to the load.
- E_{gl} where power flows from generation (likely all solar) to the load (in this case the load is the home the solar panels are on, this is often referred to as self-consumption and can be further facilitated by behind-the-meter home batteries).
- E_{gc} where power, locally generated, flows back to the grid and the generator is typically paid a feed in tariff.
- E_{cb} and E_{bc} are the power flows between the battery and the grid.
- E_{gb} and E_{bl} are power flows between the battery and the customers.

Based on the results from the power system modelling, the economic modelling can be completed that uses the battery flows, at different times of the day, the revenue generated through the forecast period and therefore how attractive this proposition is for community ownership and use..

Table 2. Key economic parameters.

Parameter	**Comment**
Tariffs	The rate at which energy is priced when importing and exporting from the battery to the grid.
Local Use of Service (LUoS)	A reduced energy transportation charge as compared to grid-wide transmission charges reflecting lower network costs when transporting energy locally (i.e., from the community battery to the community or vice versa).
Life cycle	A key technical and economic consideration impacting annualised CAPEX costs significantly.
Discount rate	The rate at which future cash flows are reduced to account for the time value of money and future risks when determining the net present value of a project.
Depreciation	The rate at which the value of the neighbourhood battery will decrease across its useful life cycle.

This project has explored the impact of adopting a 'Community Battery tariff' (in the context of an appropriate tariff to reflect a 'Local use of system' charge), in comparison to the AusNet Service Tariff Structure Statement tariffs and how this affects the feasibility for these three sites. Results from this comparison are included below (see Chapter 5). See 'Appendix A. Tariffs' for more detail.

To estimate how a battery will operate, and the associated revenue streams from this battery, various parameters are specified that are used to refine the scope and type of asset being considered within this feasibility report. The table below notes several of the main specifications for the proposed batteries of interest in this project.

Table 3. Key battery design parameters.

Parameter	**Value**	**Comment**
Battery type	Lithium	Most neighbourhood scale batteries utilise lithium-ion electrochemical cells. They generally have much higher efficiencies than other technologies, and due to their increasing ubiquity are also becoming much cheaper. Made with 100% renewable energy and 90% recyclable reduced fire risk materials.
Battery mounting	Ground	Ground mounting is a safer option (compared to pole mounted) and allows freedom with specific battery location. The CAPEX and OPEX costs for a ground mounted battery are substantially lower than an equivalent pole mounted battery.
Battery life	12.5 years	Ten-year warranties are quite typical across the industry, with AECOM project for ARENA (Grid vs Garage) suggesting 12.5 an appropriate estimate of life cycle.
Temperature range	−20 °C ~ 60 °C.	Determined by the battery type and detailed design of the battery. A critical consideration as temperatures outside of this range can cause considerable degradation in battery performance and can induce safety concerns such as 'thermal runaway' (Ma et al., 2018).
Battery capacity	Up to 320 kWh	Appropriate size for 50-100 customers, in some instances may be able to service up to 250 (Ausgrid, 2020).
Battery power	Up to 160 kW	Power rating the battery can maximally discharge or charge. Sizing crucial in relation to efficiency and transformer capacity.
C rating	0.4 - 0.5	Ratio of battery power to battery capacity, is the inverse of the number of hours to maximally charge or discharge the battery.
Charging efficiency	95%	Lithium-ion batteries typically have charging and discharging efficiencies of ~100% however charging efficiency is often impacted by upstream efficiencies.
Discharging efficiency	~100%	Typically, close to 100% for Lithium-ion batteries.
Round trip efficiency	90%	Measures energy efficiency of battery as opposed to charging efficiency, 80-90% round trip efficiency values are typical with batteries of this scale.
Transformer capacity	240 kW	All current proposed sites have a transformer capacity of 300 kVA = 240 kW.
Sound	Up to 65 dB	Quieter system is preferred, noting sound relates not to just battery but also any air-conditioning attached to the unit.

2.5 Limitations

This feasibility study has several limitations, and these are briefly outlined here.

Access to data was a key constraint to completing accurate modelling of the battery flows and revenue streams. While every effort was made to obtain site specific data at fine time scales and for several historical years, that was not always available.

Table 1 lists several authorities that have data that is critical to these studies. The main authorities are the DNSP (AusNet Services), the local council (Nillumbik Shire Council), AEMO (wholesale and FCAS prices), and Melbourne Water (as a local landowner of interest).

Formal and informal requests were made for data, with several meetings, data request forms etc used as part of this process. Halfway through the project the team approached C4Net as an organisation that facilitates data requests from DNSP and filled in a form to request data from the DNSP. This ultimately proved not to be successful but in the future data supply issues may be overcome as C4Net are able to work with DNSPs in a more efficient manner. In one example there was a cost to get a response from an agency (Melbourne Water), in the order of $250, regarding a discussion about land ownership and use.

The ability to engage with individual residents and discuss in detail the prospect of a neighbourhood battery was extensive, but more could always be done to reach more people and engage more detail. Several opportunities were made to engage with residents, but until there is a 'final offer' it is hard to get a clear willingness to use and pay from all residents. It is also limiting to be engaging with the community on this one specific project, knowing that the community will have various levels of interest in all sorts of issues associated with energy, sustainable households and vehicles, and climate action.

Thirdly, the ability to get clear agreement from landowners on the suitability of a battery on their site was problematic when this project is only a feasibility study. A significant effort was made to get in principle agreement from landowners, but more work is required on this issue. Detail on land ownership is provided below in Section 3.

Fourthly, there are uncertainties regarding the cost of the capital, and to address this industry data was collected and assumptions were made.

Fifthly, the ability to consider and model new tariffs was limited to the level of engagement from the pricing team in AusNet Services. The project looked at different tariff structures (in the form of scenarios) to overcome this issue, and these scenarios were confirmed by AusNet Services.

The project team did not explore the various battery chemical compositions, and instead relied on past projects and industry knowledge, which also relates to the cost of the capital installation.

The project team did not explicitly engage with energy retailers to test the model and feasibility with them, and instead relied on industry knowledge and the assumption that this is a growing field and there is capacity and interest in adopting and contracting with these neighbourhood batteries if they proceed.

Lastly a limitation of the modelling approach is the 'perfect predictions' of the wholesale price which make the battery operate in the most optimal way. This means that the results reflect both the best case and worse case of what the battery could have conceivably made during this period.

2.6 Project governance

The project was set up in the following manner to support the delivery of this feasibility study for a neighbourhood battery in Nillumbik. The structure of this delivery team and relationships is shown below.

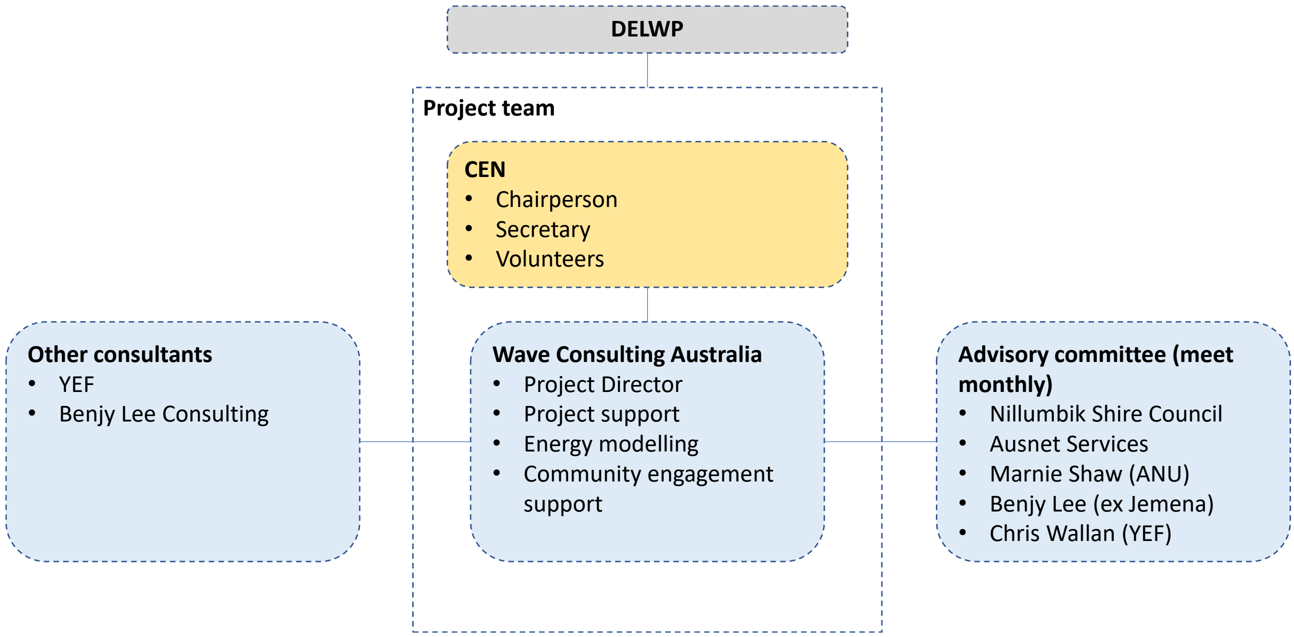


Figure 6. Governance structure

CEN have ultimate responsibility of this project and deliverables, as the signatory to the agreement.

The Advisory Group had an important role to play and was used to test ideas and provide guidance to how the project team was delivering the project.

3 Proposed sites and criteria for locating a neighbourhood battery

3.1 Criteria

Locating a neighbourhood battery involves the consideration of several factors. This chapter provides an overview of the main factors that should be considered in locating this type of battery, noting it has a specific objective as a community battery.

There are other studies that consider the costs and benefits of batteries within homes (e.g., ARENA Grid vs Garage), or connected to the Medium and High Voltage Networks, and they have different issues in determining their appropriate location. As this project has designated LV network zones, the question of where to locate a battery was more accurately a question of 'where within these LV network zones should the battery be located?'

The project did not go back and review why these three sites were chosen and relied on initial data from AusNet Services that these zones would be suitable for a battery and had relatively high solar installations behind the meter. This is the first criteria that the DNSP is supportive of the integration of this asset, in front of the meter, into the network, and was assumed to be met.

The criteria used to determine the suitability of neighbourhood battery on a specific site is as follows:

- DNSP agreement
- Proximity to a LV transformer
- Other underground services that may impact on connections
- Setback from residential houses
- Excess solar exported in this LV network
- A level of community support
- There is adequate and available open space to locate battery
- There are no other uses of this land at the moment
- No vegetation clearing required
- No impact on traffic
- Negligible noise impact
- Not subject to flooding
- The asset isn't near vegetation that may be a bushfire risk
- The landowner willing to host
- The asset can be easily maintained
- No adverse impact on amenity
- The opportunity to showcase the battery and build community pride
- A clear business case (this report)

Table 4. Qualitative assessment of factors relevant to locating a neighbourhood battery at three sites of interest (orange indicates partially met)

	Proximity to LV transformer	Underground services	Excess solar in LV network	Setback from residential dwelling	Community support	Opportunity to showcase	No prior or planned uses of land	Open space to locate battery	No vegetation clearing required	No impact on traffic	Negligible noise impact	Not subject to flooding	Not within bushfire zone	Landowner willing to host	Easily maintained	Community profile	Amenity
Luck St (original site)	✓	✓	✓	✓ (partial)	✓	✓	✓	✓	✓	✓	✓	✓ (partial)	✓	✓	✓	✓ (partial)	✓
Luck St (latest site)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓ (partial)	✓	✓	✓
Walsh St	✓	✓ (partial)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ingrams Road	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓ (partial)	✓	✓	✓

More detail on the nature of the neighbourhood battery specific locations is provided below.

The reason that some of the criteria for Luck St (original site) are flagged as only partially being met, is that the first site considered met most criteria but with local consultation and further review of planning overlays revealed that it would be compromised due to proximity to residents and location in a flood overflow path. Another site within the Luck St zone was explored for the neighbourhood battery and pending the outcome from an ongoing discussion with the landowners, the new site looks to more suitable and addresses all of the criteria.

At Ingrams Road there is also an ongoing discussion on the issue of landowner agreements, with a recent meeting with Council indicating DELWP are the ultimate landowners, and Melbourne Water and Council share the management of the site. A lease or access agreement with DELWP is required for this site (and due to time constraints, this prospect was not raised directly with DELWP in the course of this feasibility project). Discussion with Council and Melbourne Water has been positively received.

3.2 Town planning

Town planning has an influence on the suitability and conditions / design of the specific location of the neighbourhood batteries. The sites selected within the Nillumbik region are subject to a number of town planning overlays and policies that may impact on the location and design. Town planning is one of several factors that have an influence on the feasibility, and in this project a special effort was made to consider how the planning provisions would respond to this kind of application.

It is important to note that usually upgrades or additions to the electricity network would be considered to be ‘minor utility installations’, and therefore exempt from planning under Clause 62.01 and 62.02. In this instance it is currently assumed that the proposed neighbourhood batteries are **not considered** ‘minor utility installations’, but this is under active revision by DELWP and may change. Traditionally that clause relates to works initiated by the DNSP or other utilities, not a community-initiated project.

A council workshop in April 2022 reiterated the need to engage early with Council, and the location and design of the asset should:

- Minimise the impact of noise,
- Not negatively impact on the amenity of the area,
- Not impact on vegetation,
- Clearly state the use, and
- Consider options to landscape or introduce artwork.

The council also noted that **all three sites look to have minimal issues from a town planning perspective**, noting that until a formal application is lodged the Council can’t provide a definitive opinion or response.

The Council reiterated that DELWP are the final arbiter of whether these assets are included in the definition of a minor utility installation.

The table below (Table 5) reviews all the potential sites, and associated zones and overlays that apply to these sites, with commentary regarding how these potential neighbourhood batteries relate to the zones and overlays.

What is important is also which overlays do not apply in these zones, such as the fact that all of these sites did not have a heritage overlay, do not have easements, or are flagged for other uses, do not have bushfire management overlays, or subject to a development contribution or precinct planning scheme.

There are three sites of interest, but within those sites the project team explored multiple locations for a battery, and hence there are seven possible options listed in the table below. The columns in yellow are the preferred locations (one each for the three sites).

Table 5. Site specifications for each battery location option (yellow columns are the preferred options)

	Ingrams Rd Option 1	Ingrams Rd Option 2	Luck St Option 1	Luck St Option 2	Luck St Option 3	Walsh St Option 1	Walsh St Option 2
Location	Ingrams Rd. and Maroong Dr. intersection, near 27 Ingrams Rd.	Ingrams Rd. and Maroondah Aqueduct trail intersection, near existing brick wall parallel to road and above aqueduct.	North of Bible Street Reserve entrance, near 155 Bible St.	Grove St side of 154 Bible St (north face).	144 Bible St, Eltham. Kooringa Close Retirement Village	Walsh St and Porter St intersection, near 11 Porter St.	Main Rd and Bolton St intersection (northeast). Bolton St commercial area carpark.
Ownership	Melbourne Water	DELWP	Council	Council	Private	Council	Council
Asset to connect to LV poles and wires near	29 Ingrams Rd, Research	37 Ingrams Rd, Research	155 Bible St, Eltham	154 Bible St, Eltham	144 Bible St, Eltham.	15 Porter St, Eltham	Bolton St. commercial area carpark, Eltham
Zoning (See 'Appendix D. Clauses and Overlays' for more detail.	NEIGHBOURHOOD RESIDENTIAL ZONE - SCHEDULE 1 (NRZ1)	PUBLIC USE – SERVICE AND UTILITY	PUBLIC PARK AND RECREATION	NEIGHBOURHOOD RESIDENTIAL ZONE - SCHEDULE 1 (NRZ1)	NEIGHBOURHOOD RESIDENTIAL ZONE - SCHEDULE 1 (NRZ1)	GENERAL RESIDENTIAL ZONE - SCHEDULE 1 (GRZ1)	GENERAL RESIDENTIAL ZONE - SCHEDULE 1 (GRZ1)
Overlays (See 'Appendix D. Clauses and Overlays' for more detail.	SIGNIFICANT LANDSCAPE OVERLAY SCHEDULE 2 BUSHFIRE MANAGEMENT HERITAGE OVERLAY (H2O)	SIGNIFICANT LANDSCAPE OVERLAY SCHEDULE 4	SIGNIFICANT LANDSCAPE OVERLAY SCHEDULE 3 SPECIAL BUILDING OVERLAY	SIGNIFICANT LANDSCAPE OVERLAY SCHEDULE 3 SPECIAL BUILDING OVERLAY	SIGNIFICANT LANDSCAPE OVERLAY SCHEDULE 3 SPECIAL BUILDING OVERLAY	SIGNIFICANT LANDSCAPE OVERLAY SCHEDULE 2	SIGNIFICANT LANDSCAPE OVERLAY SCHEDULE 2
Design mitigations	Site is sloped – need for concrete footing to maintain battery at even level.	Reduce landscape interference by adapting size and shape to existing brick wall.	Reduce landscape interference by adapting size and shape to existing brick wall. To mitigate Special Building Overlay a raised concrete pad may be required.	Reduce landscape interference by adapting size and shape to existing brick wall. To mitigate Special Building Overlay a raised concrete pad may be required.	None required.	Site on a small slope. Avoid blocking traffic view. Battery connection has to go across the road – more infrastructure.	No impact on landscape and vegetation so no mitigation required.

3.3 Electrical connections

New connections are always subject to approvals from the DNSP and depending on the load and export rate may be rejected or limited in operation. In this case the DNSP has already noted that neighbourhood batteries connected to these LV networks are appropriate, and the focus has on finding an appropriate location for batteries with a connection of less than 160 kW (noting all three sites have a transformer of 300 kVA). Typical constraints for connections within these networks are capped around 160 kW, so this is the assumed maximum power supplied by the neighbourhood battery within each of the LV networks.

To progress to final delivery of a neighbourhood battery, a connection application would be lodged with the DNSP. For these three sites, the DNSP have advised that in principle these sites can connect but are still determining what type of information is required for an application, as this is a new augmentation and model for the DNSP.

It should be noted that a battery of this kind does not need market registration with AEMO when it is below 5 MW in capacity.

AusNet Services are yet to determine any fees associated with connection applications and approvals to the LV network. Other application fees for renewable energy generation assets are in the order of $2,500 per application.

3.4 Amenity, noise, and safety

Council planners have advised that a key issue that must be addressed, in addition to the compliance with zoning and specific overlays conditions, is the need to consider the impact of the proposed neighbourhood battery on amenity, noise impacts on the surrounding community, and the general use of this land.

More detail on the type of planning issues associated with each site is outlined below.

From a safety perspective the batteries musty comply with Energy Safe Victoria’s guidelines and the Australian Standard for Battery Storage Equipment.

3.5 Ingrams Road

Two options within the Ingrams Rd site were considered, both near the Maroondah Aqueduct trail, and near the intersection with Marong Dr. These sites have available space for connection to the AusNet substation, as well as for battery installation with the required access. Each specific site had constraints detailed in Section 5.

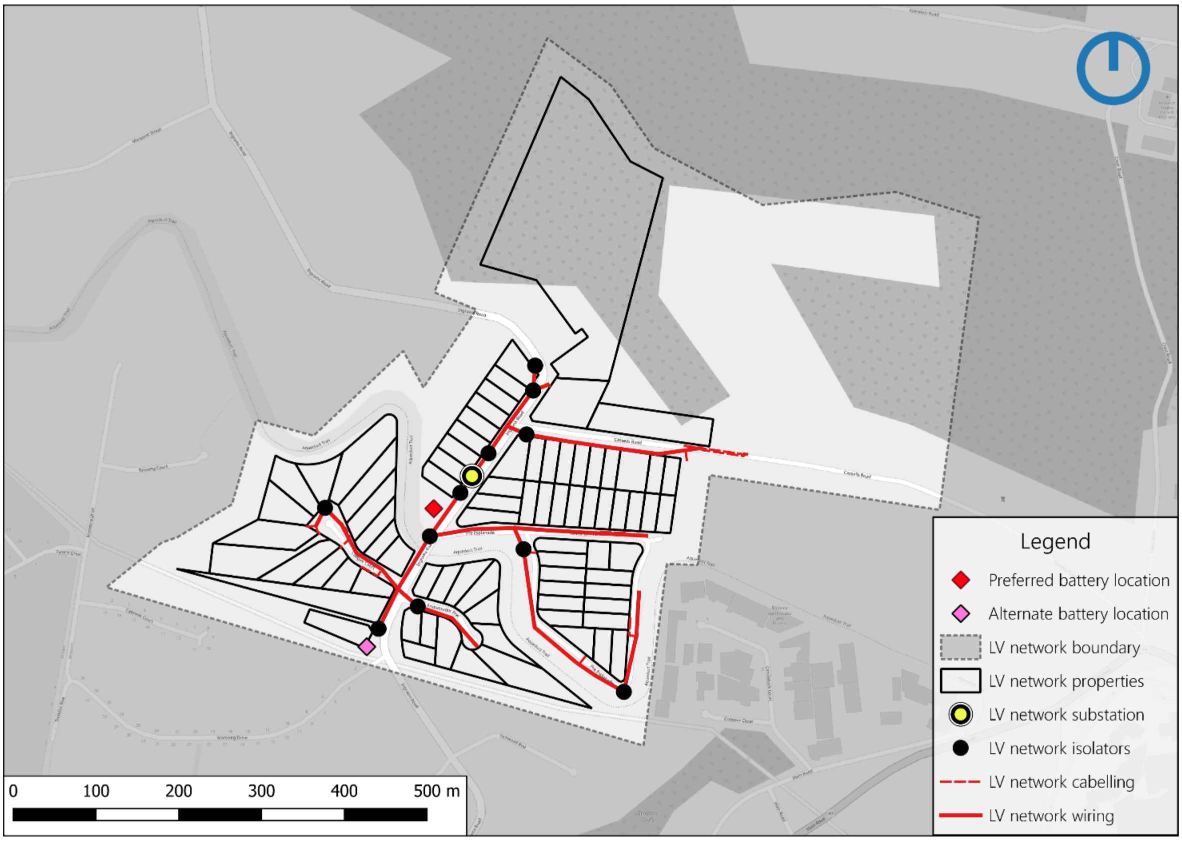


Figure 7. Ingrams Road preferred and possible battery locations.

Figure 8. Ingrams Rd site plan.

3.6 Luck St

Within the Luck St local voltage zone, there are three options in this zone: one on the west side of Bible St, one on the corner of Grove St/Bible St intersection, and one Kooringa Close retirement village, along Luck St.

One of the most important considerations for this site is the presence of a retirement home with large solar capacity and energy demand.

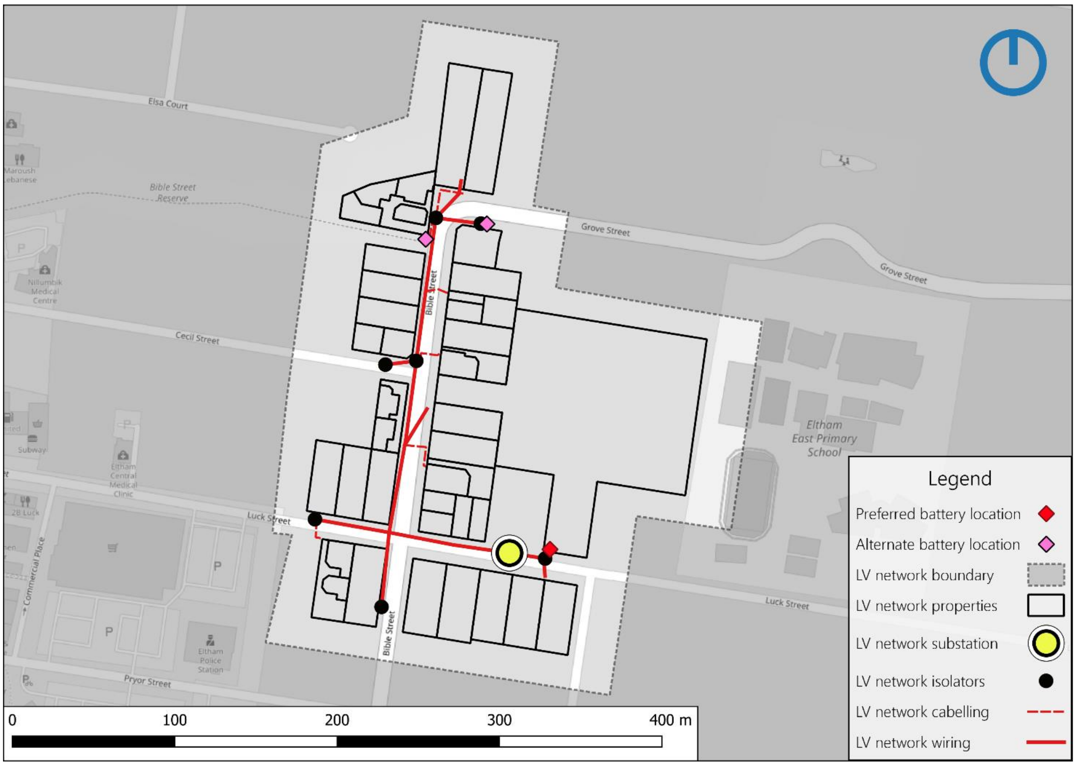


Figure 9. Luck St options for battery location

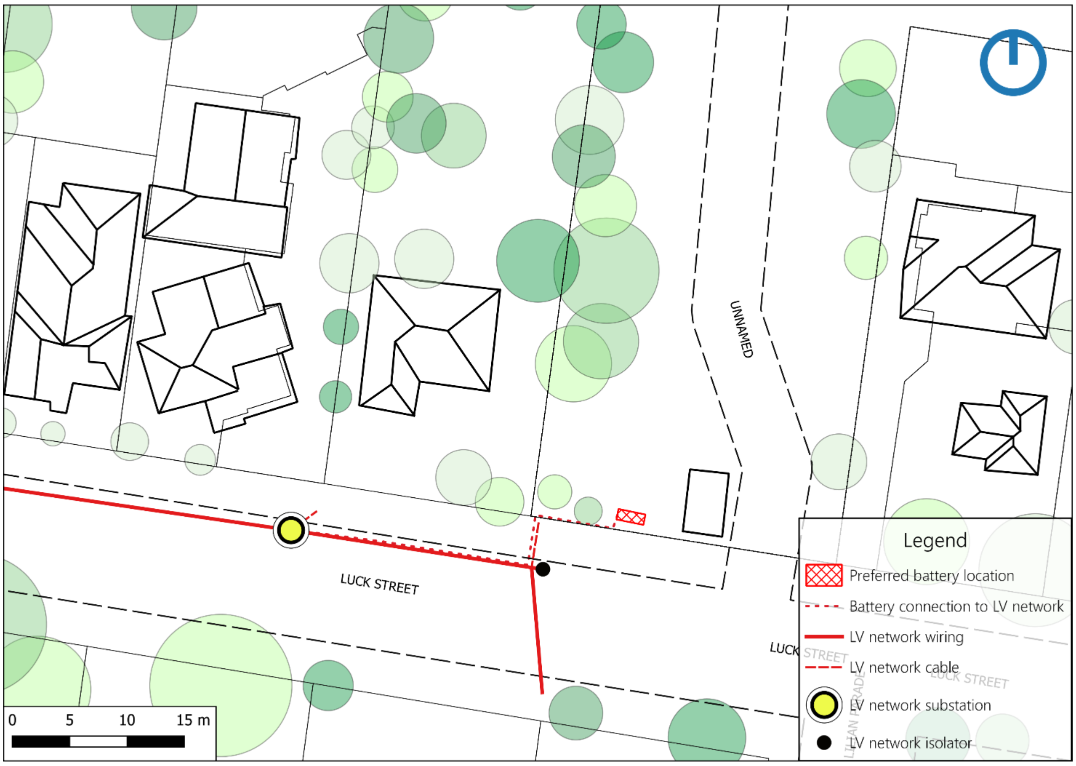


Figure 10. Battery connections for Luck St site plan

3.7 Walsh St

Within the Walsh St Low Voltage zone there are two good options to locate a neighbourhood battery: near Walsh Street and Porter Street, and just south of the shops near Main Street.

This area contains commercial properties with different demand profiles which affect the battery location and technical characteristics.

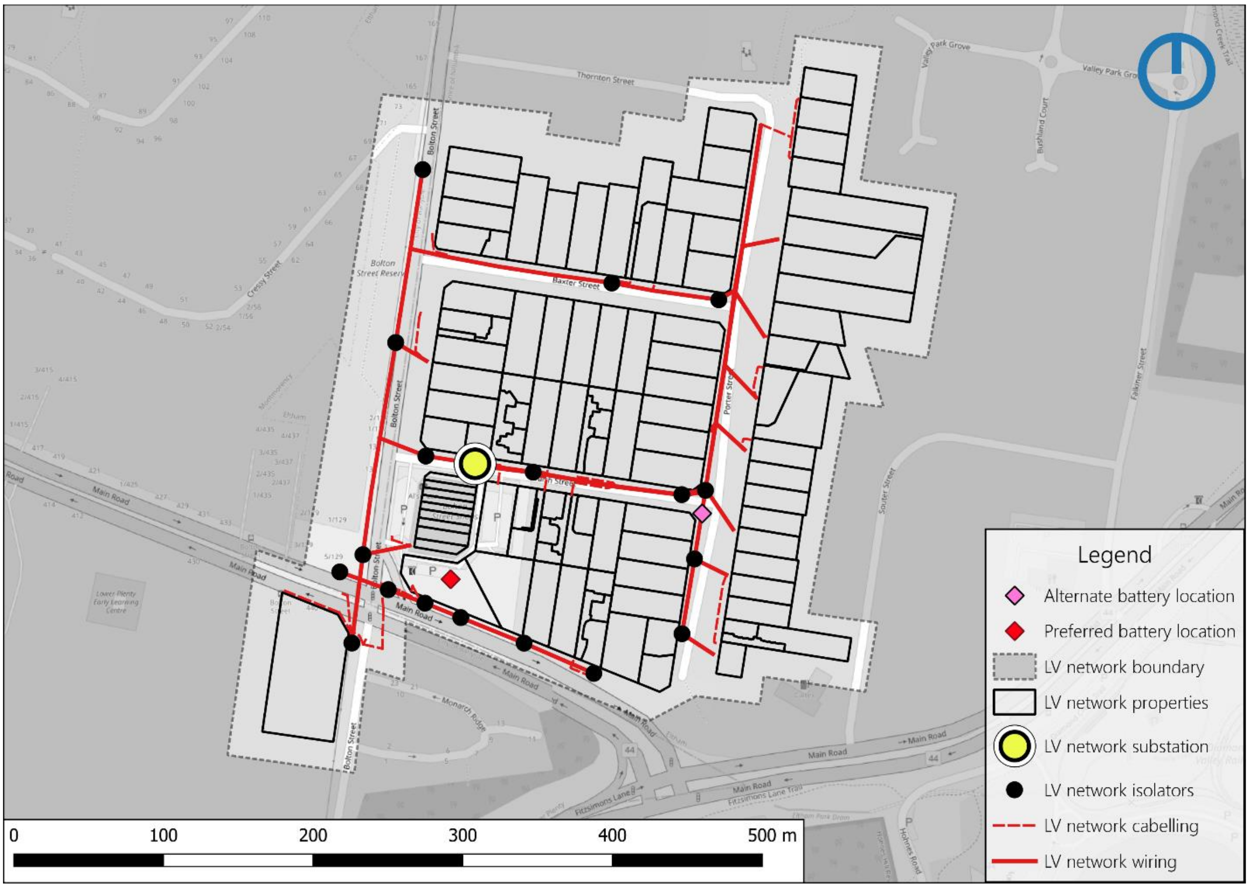


Figure 11. Walsh St battery location options

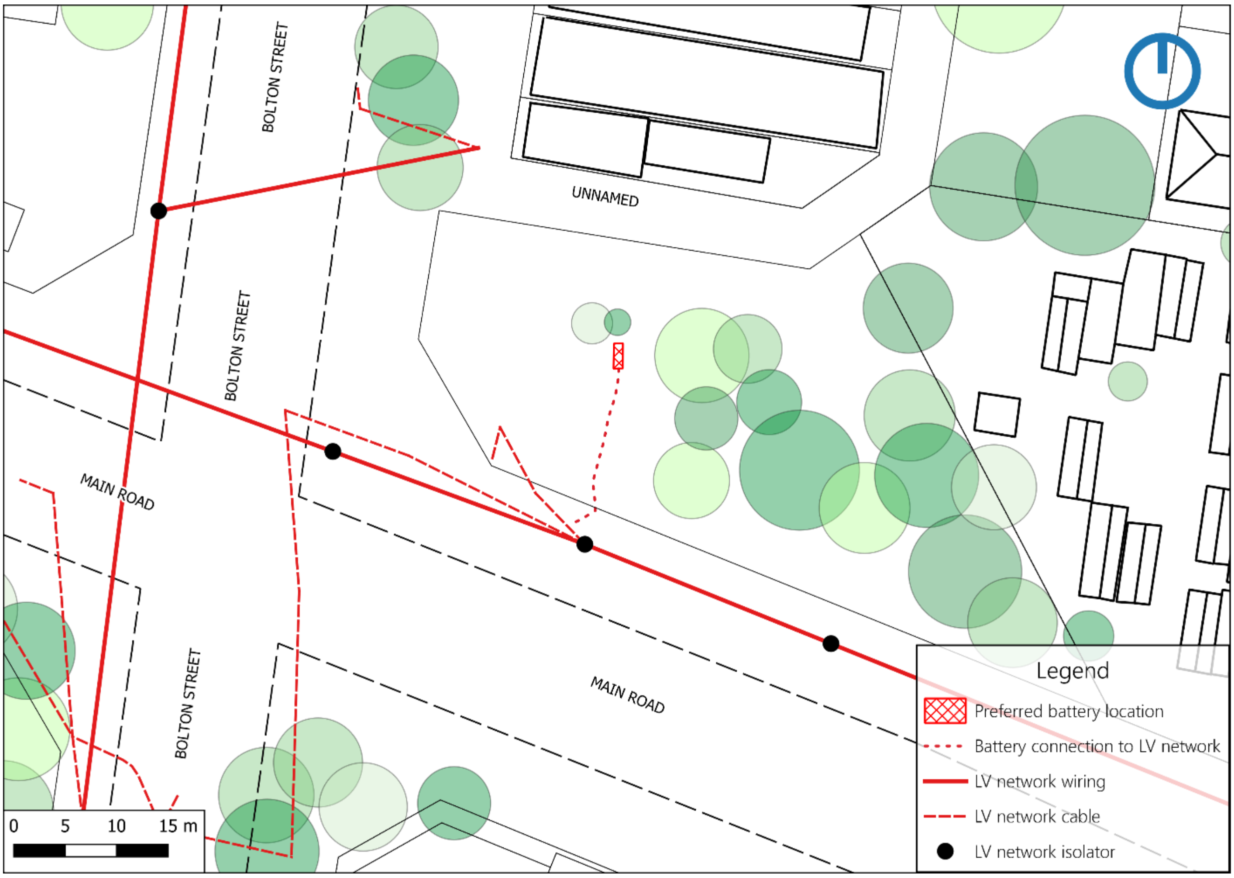


Figure 12. Walsh St battery site plan

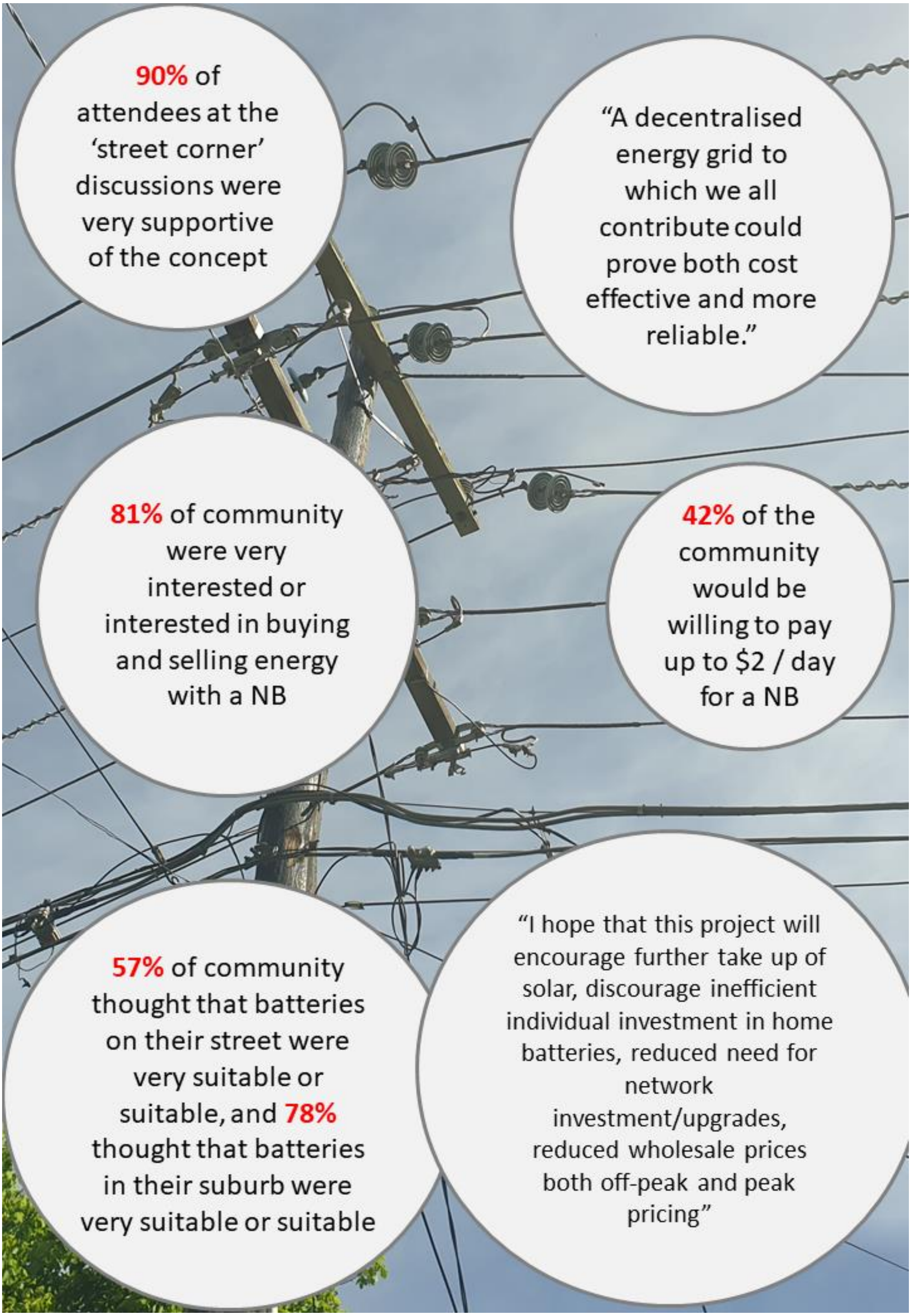
4 Community interest and support

This chapter presents the results from the main community engagement tasks completed throughout this project, with most of the quantitative data sourced from the online survey.

Generally, the community has been very interested in this concept, and have several questions around the cost, the structure, the benefits, the link with electric vehicles, and have opinions regarding the role of Council and AusNet Services.

Over the course of this project, the project team completed:

- An online survey with over 121 responses
- 2 webinars
- 200 letters to invite to street corner session
- 3 street corner engagements
- 200 letters to invite to Zoom info session
- 1 x local community Zoom Q&A for the specific sites
- 1 community champions session
- 2 events at local environment festivals
- 8 industry advisory sessions


90% of attendees at the 'street corner' discussions were very supportive of the concept
"A decentralised energy grid to which we all contribute could prove both cost effective and more reliable."
81% of community were very interested or interested in buying and selling energy with a NB
42% of the community would be willing to pay up to $2 / day for a NB
57% of community thought that batteries on their street were very suitable or suitable, and 78% thought that batteries in their suburb were very suitable or suitable
"I hope that this project will encourage further take up of solar, discourage inefficient individual investment in home batteries, reduced need for network investment/upgrades, reduced wholesale prices both off-peak and peak pricing"

4.1 Online survey

The online survey received 121 responses over the whole project, from November 2021 to March 2022. There was a $100 prize incentive for locals to fill in the survey. The online survey included 18 questions, with the main results presented here.

In terms of what action people have taken to date, respondents indicated that:

- 55% already have solar panels installed, with the rest planning to install in the future.
- 57% have heat pumps (for hot water or air conditioning)
- 20% have an all-electric home.
- 5% own a hybrid or electric vehicle or bike, with 89% of the remaining respondents planning to acquire one in the future.
- Two households already have a home battery; and 70% plan to install a battery in the future.

This data is presented below in Figure 13. Clearly the respondents were more engaged in electricity, sustainable houses, and renewable energy than the general population, but that is useful in considering who the early adopters of a neighbourhood battery would be as well.

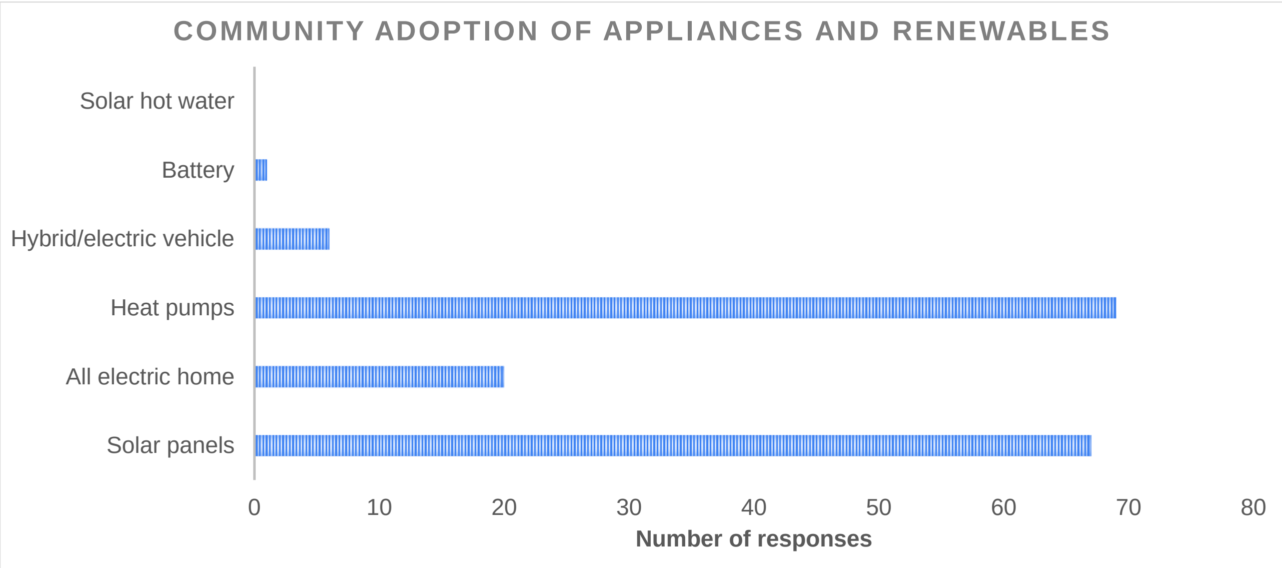


Figure 13. Current adoption of various energy / renewable options

Respondents were asked how reliable they felt the local network was in their area (see Figure 14). 36% of respondents consider the grid reliability to be between 'very unreliable to neutral', but 25% state that they believe the grid is 'very reliable'.

The issue of reliability was a key issue in terms of the expected benefits of a neighbourhood battery, where people had high expectations that a neighbourhood battery would prevent blackouts.

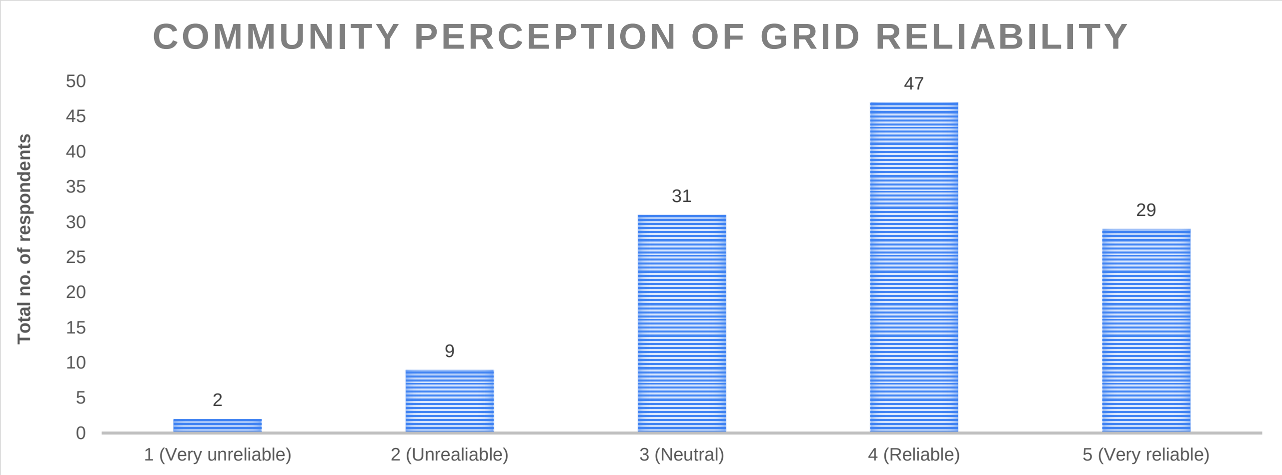


Figure 14. Perceptions of grid reliability.

The survey found that members of the community are interested in more information regarding the following key ideas:

1. Impact on their local neighborhood: noise, aesthetics, installation time.
2. The benefits.
3. The costs.
4. Saved cost: impact on bills, grants.
5. The location of the battery.
6. Timeline: when will it be installed and how long is the lifecycle of the battery.
7. Connection to existing solar.
8. Reliability and effect on current grid connection.
9. Safety.
10. Working principle.

Some respondents seem unsure how much stability a neighbourhood battery will provide to the grid (reducing frequency of blackouts, etc) and reducing costs of electricity. However, there is more consensus as to how a neighbourhood battery would avoid the need for a household one – supporting those with lower incomes – while accelerating the transition to Net Zero emissions.

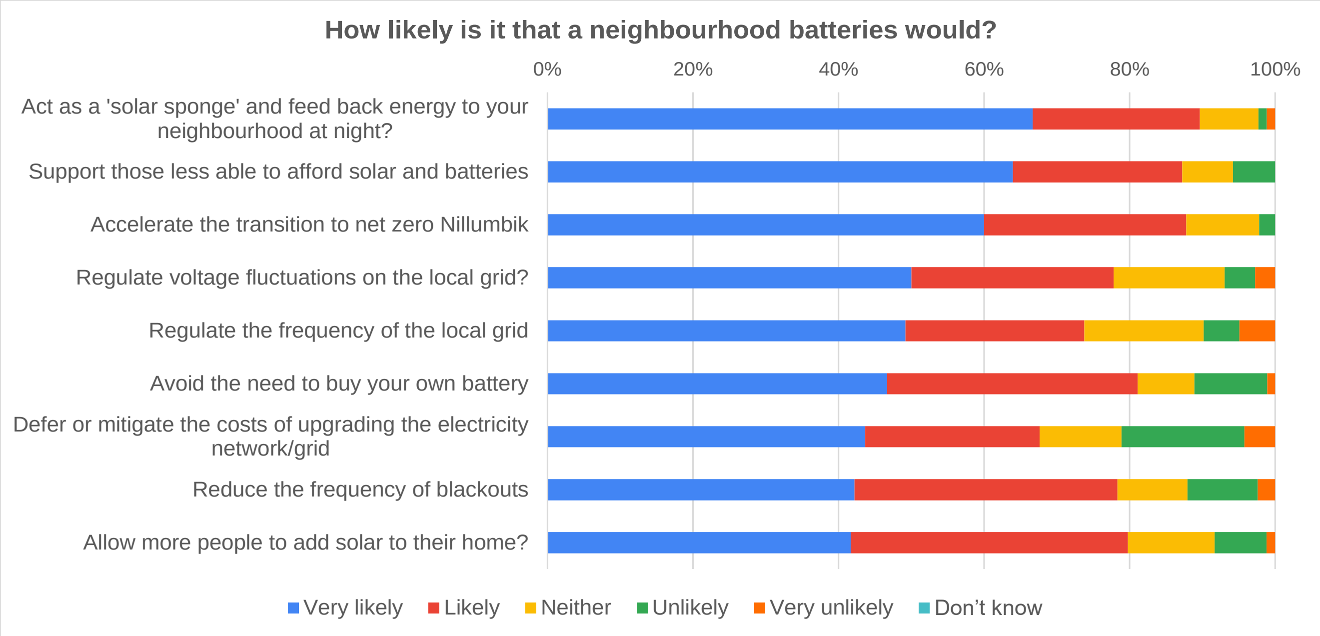


Figure 15. Battery understanding responses

Over half of the respondents would be interested in buying and selling energy to a neighbourhood battery, and 40% would consider investing/donating to it.

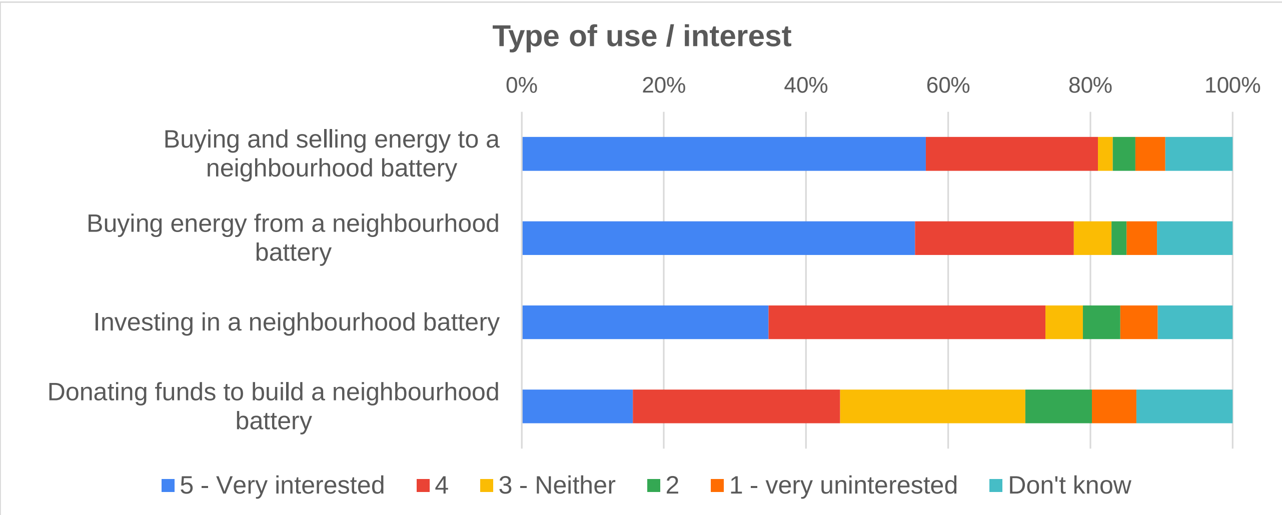


Figure 16. Community investment interest distribution

The suggestion that some members of the community may invest or donate to this asset is very important and provides an insight into the willingness to be part of something innovative and new.

While this survey was not a formal 'willingness to pay' survey, it did reveal some interesting results when the question was posed about how the community feels regarding investing or spending money on this venture. Approximately 20% of the respondents believe they should save money or at least not have to invest in the battery.

42% would be willing to spend between $0.25/day and $2.00/day for access to a neighbourhood battery. This was not further explored in terms of tariffs and consumption data.

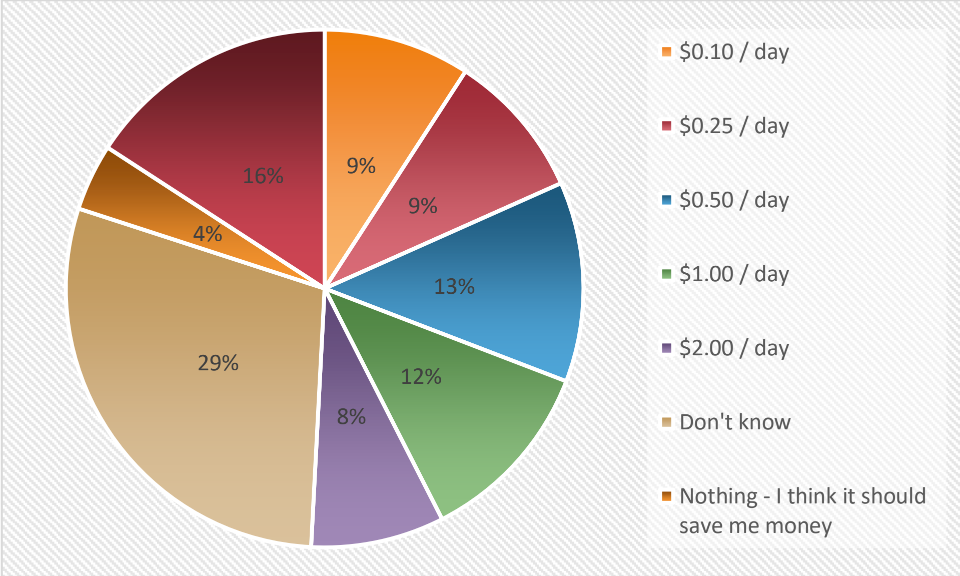


Figure 17. Community investment interest distribution

The community finds locations more suitable when they don't directly impact their households, for example by locating the battery in a nearby local substation or a park. Most of them suggest non-residential areas as potential locations.

People did have some uncertainty as to the actual size and look of the neighbourhood battery, which obviously has some influence on how they respond to this question on a suitable location. They would like to understand more about noise, aesthetics, maintenance, safety, and environmental issues before deciding.

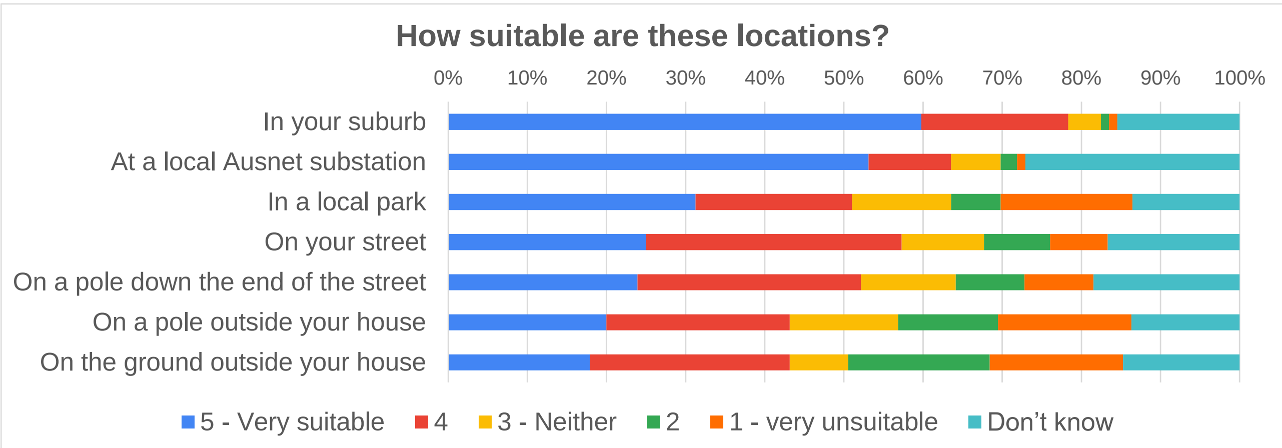


Figure 18. Suggested location distribution

4.2 Street corner conversations

Feedback was sought from the broader Nillumbik community through festivals, online engagement, and online surveys, and then the project also sought to engage heavily with the specific three zones of interest through online letters, door knocking, street corner dedicated meetings, and an online Zoom meeting.

A 'street corner' conversation was convened for all three zones in February and attended by between a few and 15 people / households. The project team suggest that this is a very strong turnout considering only 90 households (those connected to that particular LV network) were invited and they were given one to two weeks' notice. As expected, attendees had concerns, queries, and questions (outlined below), but overall had a strong interest in a potential neighbourhood battery in this area. It was a very engaging and passionate group, that came to discuss neighbourhood batteries with just a week's notice.

90% plus were broadly supportive of the concept, on both the local scale and the wider transition away from non-renewable forms of energy.

One household appeared to be dismissive of the idea entirely and failed to see any tangible benefit, but in the context of engagement across all zones, it was interesting that there was only one household amongst with this view.

When discussing potential locations for the battery in the immediate vicinity, attendees were not concerned at all after it was explained that the battery itself would have an approximate footprint of up to 3 m^2.

A common query regarding the battery was its ability to mitigate blackouts for residents. Approximately 50% of attendees were keen to see a battery reduce the frequency of blackouts.

The main questions posed were:

- Who would own it?
- What would happen if we left the area?
- What would happen if my neighbour used the power that night?
- How would the retirement village interact with this asset?
- Is this a fire risk?
- Will power be cheaper?
- How will the load shifting/energy trading be managed?
- Will anything change to my house?
- How much will it cost?
- Why can't Council take more of a leadership role?
- If I don't have solar, can I participate?
- If I am on the 66 cents feed in tariff, then can I participate and will I lose that tariff? Can I opt out of it?[1]
- What happens if it gets damaged?
- Shouldn't AusNet invest in this infrastructure, as the main beneficiaries?

Some other comments included:

- What will the role of EVs play?
- Do we have the option of investing in it?
- Who is going to pay for it?
- Is it better to wait until this technology is cheaper and more reliable?

[1] DELWP advised in person that feed in tariffs would not be impacted by a neighbourhood battery.

All of the above questions were mostly discussed and addressed on the spot, and the sessions finished with all of the community satisfied with the concept and hoping to learn more in the future and see this come to fruition.

4.3 Neighbourhood champions

Lastly, from a community engagement perspective the project also included a session on how to extend the project beyond these three zones and create a community network of champions.

Community members interested in becoming champions were identified by including a specific survey question to ask if they were interested in being an advocate, and also raising that prospect in the general information webinars that were run in December 2021 and assessing interest through other project-related engagement activities (e.g., online surveys, street corner meetings etc).

While the battery champions capacity building event was intended to be held as a face-to-face gathering at a Nillumbik Shire Council community meeting facility, the approach was quickly pivoted to plan for hosting an online engagement event due to the Omicron Covid outbreak. Nillumbik Shire Council and AusNet Services were targeted as key stakeholders to also participate in the event, and lead part of the discussion, and were engaged in the lead up to the event via meetings as part of the event preparation.

Given online events can be more difficult to achieve both the depth of engagement and bonding between participants, a phase of pre-event engagement was also adopted in the form of an introductory phone call conversation with prospective champions.

Conversations with over 10 prospective champions were had in the lead up to the event, allowing for a warm introductory experience and providing a sense of skills and capabilities that they could apply to assist the project. From these conversations a **'collective superpower word cloud'** was created to present at the online event to show the strong diverse yet complementary skillsets that the group could leverage from.

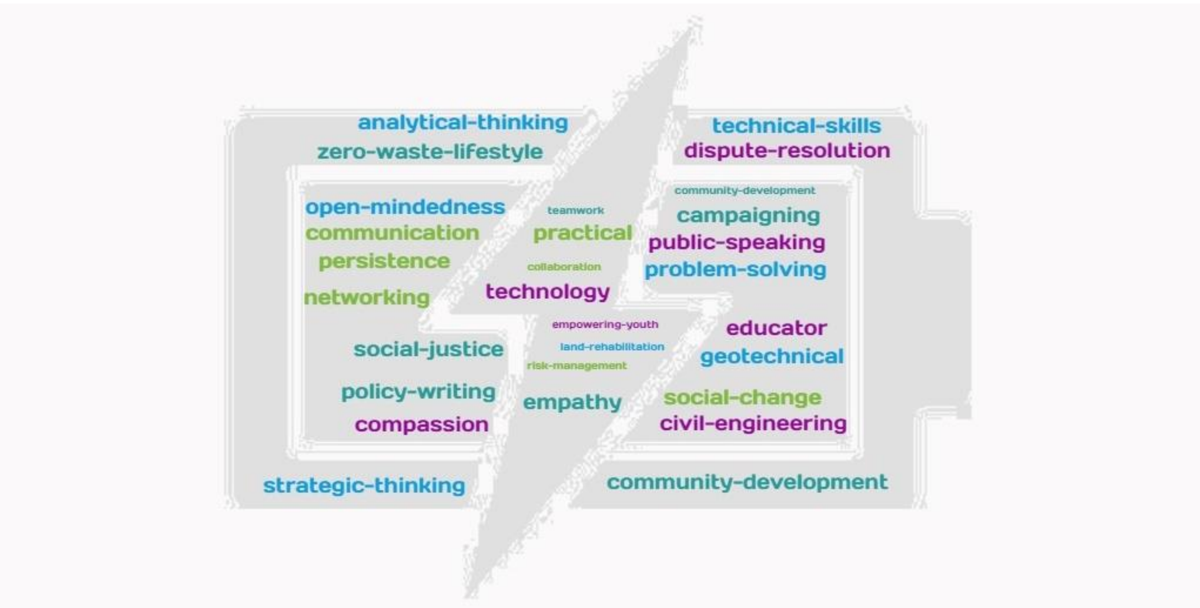


Figure 19. Battery champions collective superpower word cloud

The online battery champions event was held on a Saturday afternoon in February, attended by 18 community champions (a further 5 were apologies but could watch the recording of the session), along with strong Nillumbik Shire Council representation. Closing remarks were delivered by the Deputy Mayor Cr Ben Ramcharan, while the Mayor Cr Frances Eyre was also present for the full session. Benjy Lee from BLC was the event facilitator.

A DELWP representative attended the session to provide participants with an overview of Victorian Government's Neighbourhood Battery Initiative program. Wave Consulting provided a more detailed and technical presentation, while CEN Chair Natalie Bucknell provided participants with a project overview and sought the interest of the participants in assisting current feasibility project work in four ways:

- engaging local people in the three locations to build more awareness of neighbourhood batteries and benefits
- supporting the feasibility study with aspects such as researching ownership models and regulatory considerations
- engaging with other key stakeholders (e.g., AusNet Services, Nillumbik Shire) on feasibility project recommendations
- writing grant submissions for funding to assist neighbourhood battery project development.

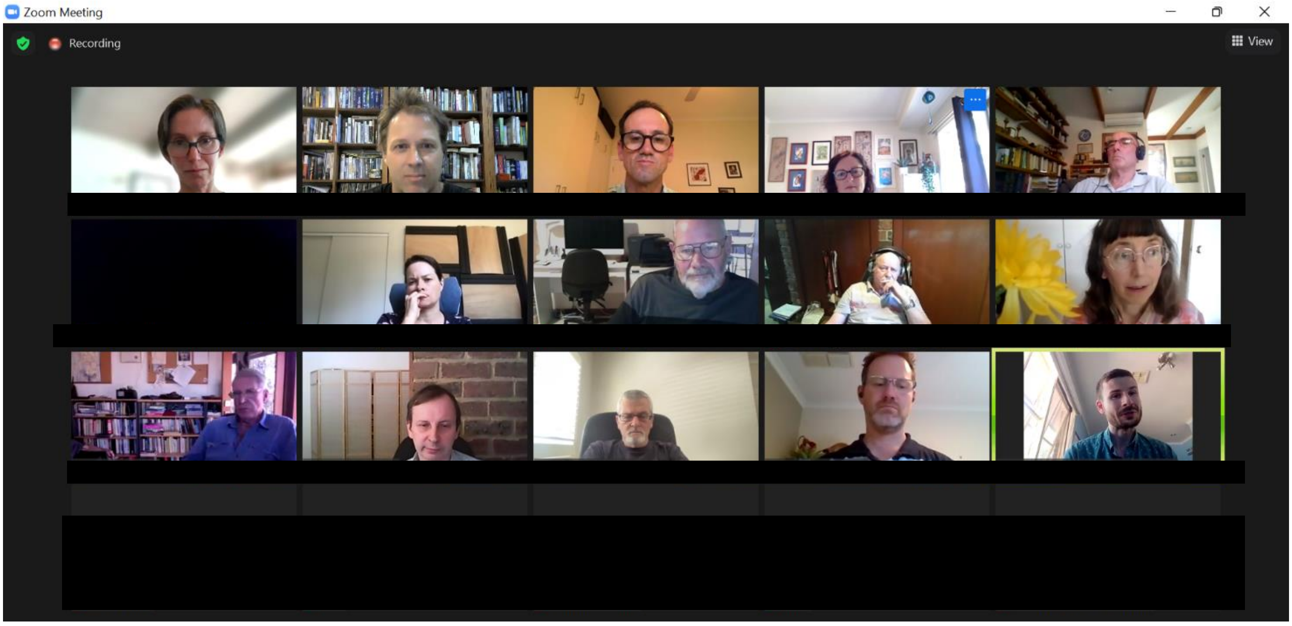


Figure 20. Online community champions session on Saturday 19th, facilitated by Benjy Lee.

Participants were highly engaged in the online event, with a broad range of champions offering to assist CEN by lending their capabilities across marketing, policy and regulatory development, strategic planning, project management, engineering, and other technical areas of support. There was also useful information shared in discussion and posted to assist the feasibility work.

5 Financial results

5.1 The neighbourhood: total electricity imported and solar generation

There are approximately 80 to 120 properties (or unique National Metering Identifier (NMI) connections, mostly residential) within each of the three local voltage networks of interest.

Analysing aggregated consumption data at the substation transformer, the project team was able to determine the scale of power usage, solar generation, and the frequency and scale of exporting of excess solar generation within these three zones.

A summary of the main results of the local voltage networks is shown below in Table 6.

Table 6. Summary data of proposed low voltage networks

Parameters	**Ingrams Road, Research**	**Luck Street, Eltham**	**Walsh Street, Eltham**
Number of customers	80	90	121
Installed solar[2]	100 kW	125 kW	67 kW
PV penetration (percentage of households with solar photovoltaics installations)	31%	64%	17%
Transformer capacity	240 kW	240 kW	240 kW
Average 15-minute demand (summer)	40.1 kW	23.3 kW	86.0 kW
Average 15-minute demand (winter)	58.5 kW	41.4 kW	98.7 kW
Max 15-minute demand	178.0 kW	108.0 kW	266.0 kW
Min 15-minute demand	-11.0 kW	-39.0 kW	0.0 kW
Pre COVID annual usage	385,617 kWh	264,302 kWh	748,030 kWh
Pre COVID daily usage	1,059 kWh	726 kWh	2,054 kWh
Pre COVID daily usage per customer	13 kWh	5 kWh	16 kWh
Post COVID annual usage	421,423 kWh	259,283 kWh	795,525 kWh
Post COVID daily usage	1,154 kWh	710 kWh	2,178 kWh
Post COVID daily usage per customer	14 kWh	5 kWh	17 kWh
Post COVID usage change	+9.29%	-1.90%	+6.35%
Estimated total annual solar exported	49,000 kWh	30,000 kWh	34,000 kWh
Estimated total annual solar exported / total NMI connections	612 kWh	250 kWh	375 kWh

It is important to note that in winter there is a higher peak compared to summer, and higher average usage. The figures below (Figure 21, Figure 22, and Figure 23) show this in a graphical sense.

Ingrams Road is recording the greatest level of solar exporting (at 49,000 kWh each year) at the transformer and would therefore be assumed to be the most suitable of these three sites for a neighbourhood battery.

Visualisations of these power consumption are shown below for each of the three zones.

[2] AusNet Services, 2022. Per comms. Informal conversation re PV installed capacity.

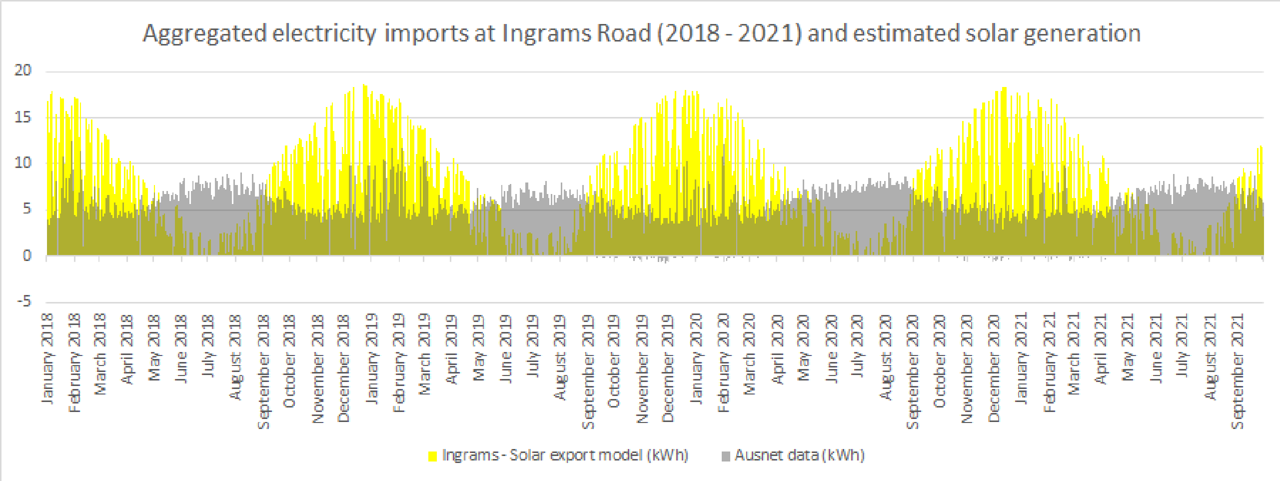


Figure 21. Imports and exports within Ingrams Road zone

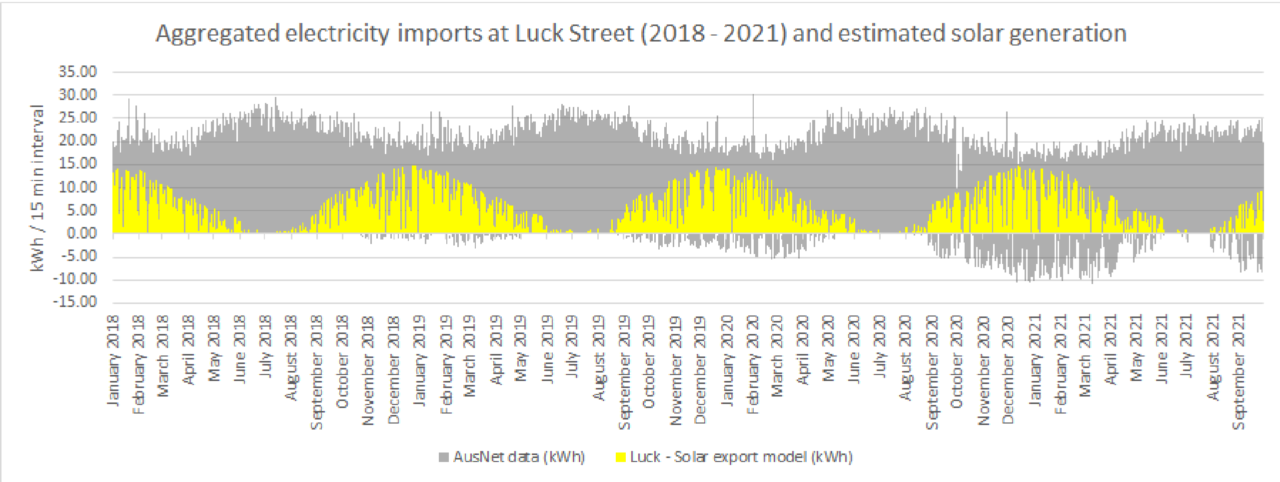


Figure 22. Imports and exports within Luck St zone

In Luck St there is currently some exporting of power through the substation transformer, but more solar installations within this zone could be supported by the introduction of a neighbourhood battery (or several behind the meter home batteries).

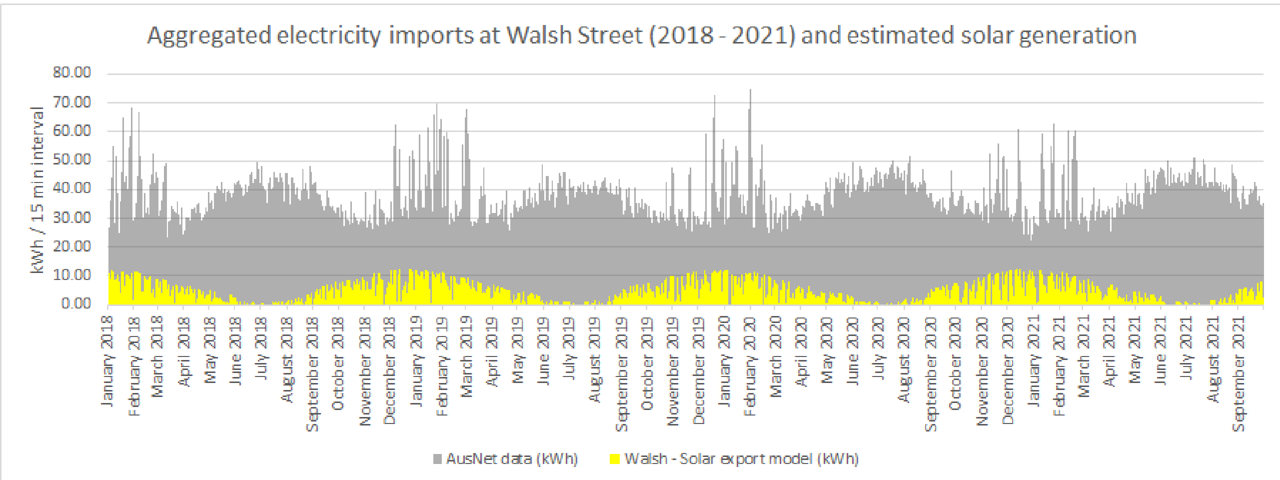


Figure 23. Imports and exports within Walsh St zone

It appears from this usage data that there could be 2 to 4 times more solar installed in the Walsh St zone to generate more local renewable energy, store it in a neighbourhood battery, and then use that same electricity in the peak evening period. This feasibility report models the current solar generation within Walsh St, but it should be noted that ideally more solar could be installed in this zone and this would improve the feasibility of a possible neighbourhood battery.

Walsh St does seem to have significant spikes in power usage. It should be noted that in Walsh St (the LV network that has the highest demand), there are approximately 10 small businesses that are located on Bolton St.

5.2 Sizing of battery

The battery was sized for each of the three zones according to the scale of solar exports. As seen above, in the Ingrams Road zone there is the greatest quantity of solar exported, so that battery is sized to be the largest of the three.

This means if there is a large amount of exporting from several houses (so their household or small business demand is well below the generation, and they have no storage), then the neighbourhood battery can be sized to be charged with this exported solar generation. This is limited though to be up to 320 kWh, again due the connection limit.

There is little to gain from building larger batteries than available solar (unless there is real confidence that more solar will be installed in the near term), as this will see a large capital expenditure and reduced ongoing revenue.

The size of the batteries modelled in this feasibility study are as follows.

Figure 24. Batteries modelled at each of the three zones

	Ingrams	**Luck**	**Walsh**
Capacity (kWh)	280	200	180
Power (kW)	125	90	80
c value[3]	0.45	0.45	0.44

The c value is "*a measure of the rate at which a battery is discharged relative to its maximum capacity. A 1C rate means that the discharge current will discharge the entire battery in 1 hour. For a battery with a capacity of 100 Amp-hrs, this equates to a discharge current of 100 Amps. A 5C rate for this battery would be 500 Amps, and a C/2 rate would be 50 Amps*." [4]

As noted above in the discussion on 'Constraints' a neighbourhood battery at this scale can only reach a maximum power of 160 kW. Because the battery obtains most of the revenue from its power in the FCAS market, an increase in the size of battery is linked with greater revenue.

There is a 90% round trip efficiency of the battery. A higher round trip efficiency would increase wholesale revenue and network revenue of the system.

Only 80% of the battery capacity is used. E.g., for a 200kWh battery, only 160kWh is used. By reserving the top and bottom 10% of the battery it degrades slower, extending its life, and allows for continuous bidding into the FCAS markets.

[3] MIT, 2008. A Guide to Understanding Battery Specifications. Accessed at http://web.mit.edu/evt/summary_battery_specifications.pdf
[4] MIT, 2008. A Guide to Understanding Battery Specifications. Accessed at http://web.mit.edu/evt/summary_battery_specifications.pdf

5.3 Forecasting future revenue

Modelling was completed and generated results for the revenue of the battery for the next 11 years (2022-2023), at 30-minute data intervals. This modelling was designed and run by Yarra Energy Foundation (YEF) using the C3X model, a model that was developed through ANU. Based on this detailed set of results it is possible to extrapolate revenue out to 20 years. A linear constraint programming optimisation method was used, for which a system is defined, inputs (market price predictions) are fed in, and the optimiser will run daily battery cycles optimising profits. See 'Appendix B. Modelling' for more detail.

The battery was assumed to have a 90% round trip efficiency (affecting network and wholesale revenue) and a cap of 80% on capacity to extend its life (affecting FCAS revenue).

Note that batteries can only participate in the FCAS market if they are either greater than 1 MW, or part of an aggregated model to deliver more than 1 MW of capacity. It is assumed that these neighbourhood batteries are managed through a retail aggregator, and therefore can generate this FCAS revenue.

The FCAS market is designed to ensure the NEM maintains a frequency at 50Hz: 24 hours a day, 7 days a week all year round. For example, a change in load that impacts on frequency is shown below, capturing the different response periods and the nature of the FCAS market. See 'Appendix B. Modelling' for more detail.

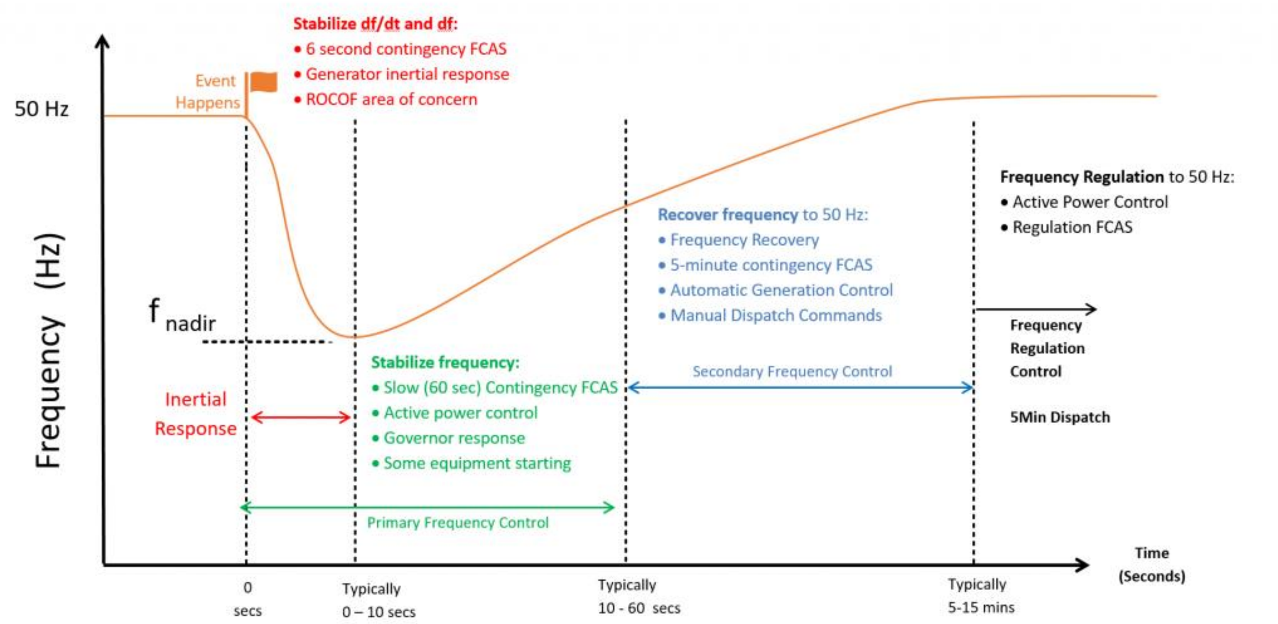


Figure 25. Example of frequency response (Source: Dyson, J., 2017. Let's talk about FCAS. Published on Wattclarity.com)

Three scenarios were generated to predict market prices, and inputs were predicted from historical wholesale price data with similar attributes.

- **High revenue forecast**: accelerated exit of coal causing a slow decline of the FCAS market – $100,000/MW/year in 2029.
- **Medium revenue forecast**: less accelerated exit of coal causing a medium decline of the FCAS market - $70,000/MW/year in 2028.
- **Low revenue forecast**: on time exit of coal leading to lower market volatility during transition and government intervention to avoid it further. Fast decline of FCAS market - $40,000/MW/year in 2025.

The results of this forecasting of revenue are shown below. See 'Appendix B. Modelling' for more detail.

The four revenue streams, also referred to as the value stack, are as follows:

- **Wholesale**: revenue associated with buying energy at low prices (daytime) and selling at higher prices (night-time).
- **FCAS lower**: revenue associated with the FCAS market to lower the frequency (over a fast (6 second), slow (60 second) and Delayed (5 minute) time frame).
- **FCAS raise** revenue associated with the FCAS market to raising the frequency (over a fast (6 second), slow (60 second) and Delayed (5 minute) time frame).
- **Network**: Sum of revenue (negative and positive) for importing and exporting of electricity as governed by network tariffs and time of use periods. Note if there is an incentive (i.e., a negative tariff) to charge or discharge the battery, the battery will have a positive revenue stream, but if there is cost to importing or exporting, then the battery will have a negative revenue stream. This element is the sum of this analysis over every 30-minute period).

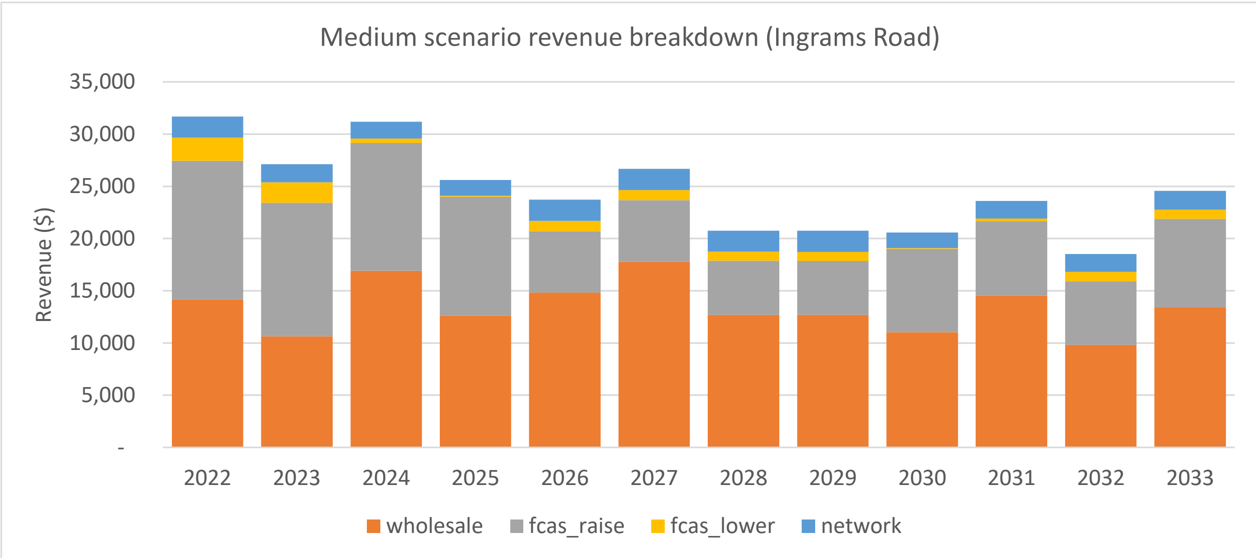


Figure 26. Forecast revenue streams for Ingrams Road LV network

Revenue is forecast to generally decline, more so for FCAS related markets than for the wholesale market. Network revenue is relatively small in comparison to the other revenue streams.

Under this medium forecast, revenue per year for the Ingrams Road battery would be between $20,000 and $30,000.

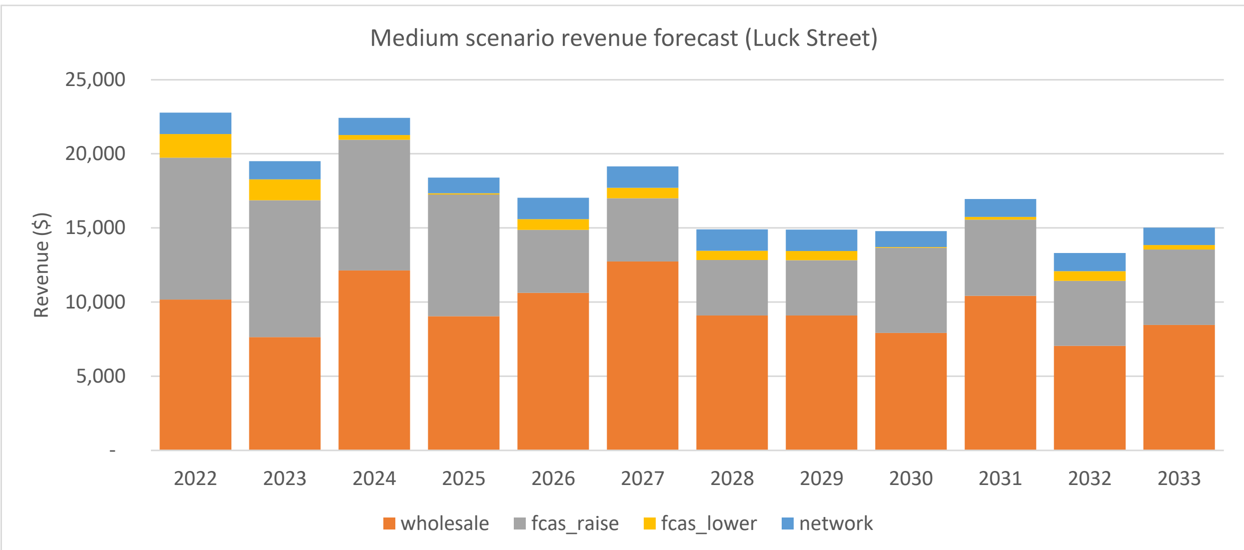


Figure 27. Forecast revenue streams for Luck Street LV network

Revenue is forecast to generally decline, more so for FCAS related markets than for the wholesale market. Network revenue is relatively small in comparison to the other revenue streams.

Under this medium forecast, revenue per year for Luck Street battery would be between $15,000 and $25,000.

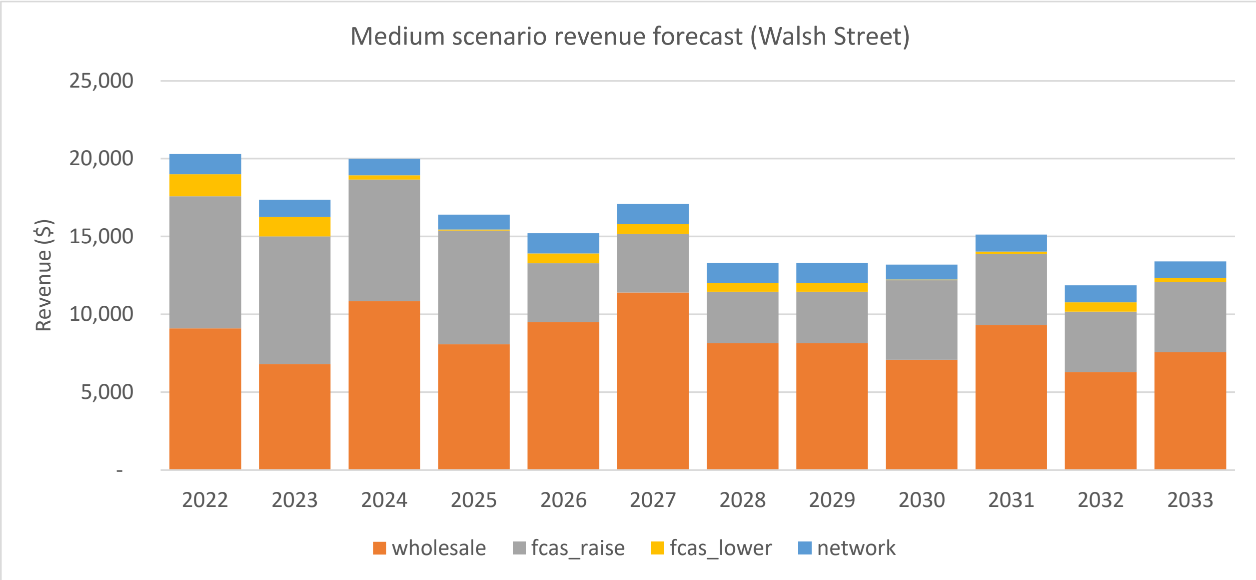


Figure 28. Forecast revenue streams for Walsh Street

Revenue is forecast to generally decline, more so for FCAS related markets than for the wholesale market. Network revenue is relatively small in comparison to the other revenue streams.

Under this medium forecast, revenue per year for Walsh Street battery would be between $10,000 and $20,000.

5.4 Costs of batteries

With the development of storage technologies and the need to install more batteries, the cost is expected to decrease per unit of energy over time, however there are still a number of components that must be considered at present value which affect the financial feasibility of the project. This section considers the cost of a Li-ion battery (noting that this proposal is for an 'in front-of-meter' battery) as well as associated expenditure with its installation, maintenance, civil works, hardware connection, etc.

A Lithium-ion battery has been chosen as it is the most commercially available form of storage for the required capacity. The technology has developed to good performance characteristics in power applications.

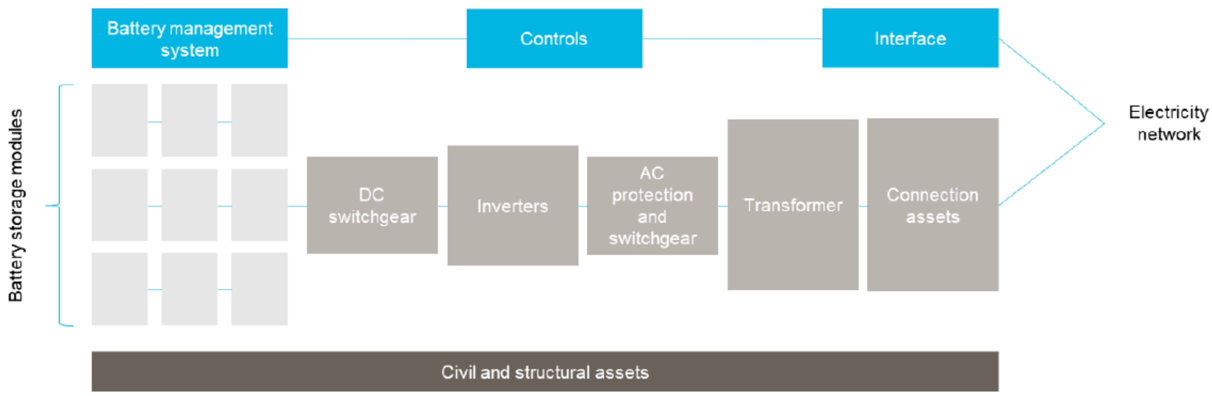


Figure 29. Grid connection components for an in front of meter battery (ARENA, 2019)

Using a bottom up approach the cost of a medium size battery system can be estimated from the following main factors:

1. The battery system including the Lithium-ion modules for power storage.
2. The power equipment includes inverters and switch gear.
3. Controls and communication: non-recurring engineering costs for energy management in terms of software management and its associated hardware costs.
4. Grid integration consists of transformer, busbars, safety mechanisms, meters, cabling, and connection assets as well as installation.
5. Any civil works necessary to install the battery.

A brief breakdown of the capital and operating costs is shown below in Table 7.

Table 7. Bottom-up cost estimation

	Ingrams	**Luck**	**Walsh**
Capacity (kWh)	280	200	180
Power (kW)	125	90	80
Battery module	$ 224,000	$ 160,000	$ 144,000
Other costs (controls, protection, installation)	$ 66,000	$ 59,000	$ 57,000
CAPEX ($)	$ 290,000	$ 219,000	$ 201,000
CAPEX ($/kWh)	$ 1,030	$ 1,090	$ 1,120
TOTAL Opex / yr	$ 7,100	$ 5,800	$ 5,500

Verification of costs was sought from major industry contacts and AusNet[5], who have confirmed informally that an equivalent cost rate of $1100 / kWh is appropriate for this type of asset.

The total capital required for these three batteries is around $720,000.

5.5 Summary of financial feasibility

An NPV analysis was completed to determine from a financial perspective the feasibility of each of the three neighbourhood batteries. A positive NPV value would be considered to be a sound investment.

The results are that two of the three projects have a positive (or very close to positive) NPV. The NPV presented here is based on the 'medium' forecasts of future wholesale prices and FCAS markets, and also uses a 'community battery' tariff structure on the basis that the industry is moving to this model, and a 7% discount value.

The total capital required for these two batteries with a positive NPV is $510,000.

The Walsh St battery is the smallest of the three potential batteries and has the highest ratio of fixed costs to capex costs for the installation. The relative operating costs are higher for this smaller battery too. It is difficult to justify investment in this particular battery in this local voltage network.

The NPV is not the only metric used to determine the feasibility of a project but is an important metric to consider in proceeding with a project.

[5] AusNet Services representative, 2022. Email note re approximate costs of LFP batteries on 8th April 2022.

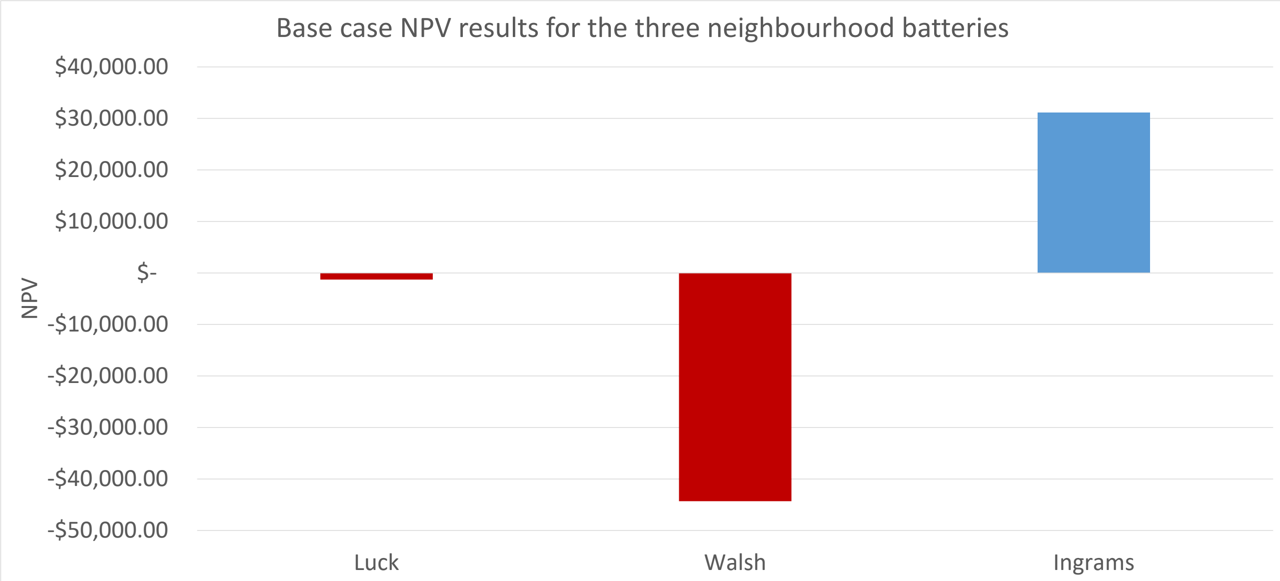


Figure 30. NPV for base case.

A key consideration for all potential neighbourhood batteries is how network tariffs apply to the operation and financial model. While network revenue (i.e., revenue that the DNSP would pay the battery owner through negative rates for importing and positive rates for exporting power) is a small portion of the total revenue, if a community battery network tariff structure is not adopted, then the battery would be paying the DNSP for each kWh imported throughout the day (or a variable charge based on the time of use). This is the current network tariff structure that all residents and small businesses are paying now. See 'Appendix A. Tariffs' for more detail.

A community battery tariff is a tariff being trialled in other DNSP areas, that is structured to incentivise charging of the battery in the daytime, and discharging in the night time. Citipower / Powercor[6] have an approved trial for a community battery tariff, to commence on 1 July 2022. See 'Appendix A. Tariffs' for more detail.

The figure below highlights that the batteries would lose between $40,000 and $120,000 total revenue over the 12.5 years of the life of the battery if the community tariff structure is NOT ADOPTED.

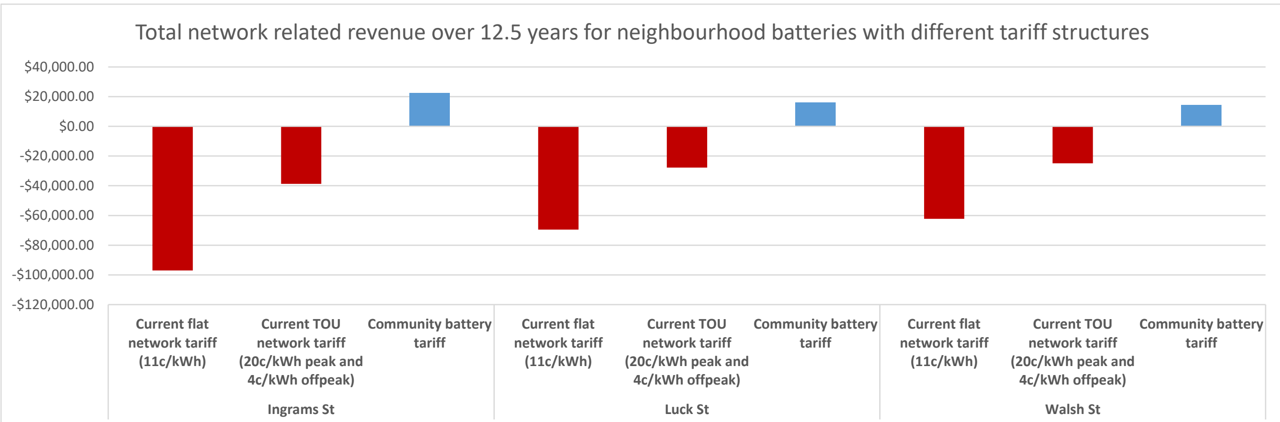


Figure 31. Variability in 'network revenue' only, with various network tariff structures.

[6] AER, 2022. CitiPower Trial tariff notification 2022-23. Accessed at https://www.aer.gov.au/system/files/CitiPower%20-%20Tariff%20trial%20notification%20-%202022-23_1.pdf

5.6 Sensitivity and unknowns

Sensitivity of various parameters was modelled to determine a) what parameters would impact on the feasibility the most, and b) provide more confidence and data to manage the perceived risk of investing in these neighbourhood batteries.

The parameters that were varied in the sensitivity analysis included:

- Battery size (-25%, -10%, +10%, +25%, +50%, +100%) which is dependent on solar penetration
- Battery life cycle (10 years, 12.5 years, 15 years, 20 years)
- Forecast revenue (low, high)
- Import day-time network tariff rates (-1.5 cents / kWh, +11 cents / kWh, +4 cents / kWh in off peak and +20 cents / kWh peak)
- Import night-time network tariff rates (25 cents / kWh, 20 cents / kWh, 15 cents / kWh)
- Discount value (3%, 5%, 7%, 10%)
- Capex of installed battery ($750 / kWh, $1000 / kWh, $1500 / kWh, $2000 / kWh)
- Administration / governance fee ($500 / yr, $1000 / yr, $2,500 / yr, $5,000 / yr, $10,000 / yr)

The figures below highlight how the NPV varies with the adoption of different parameters.

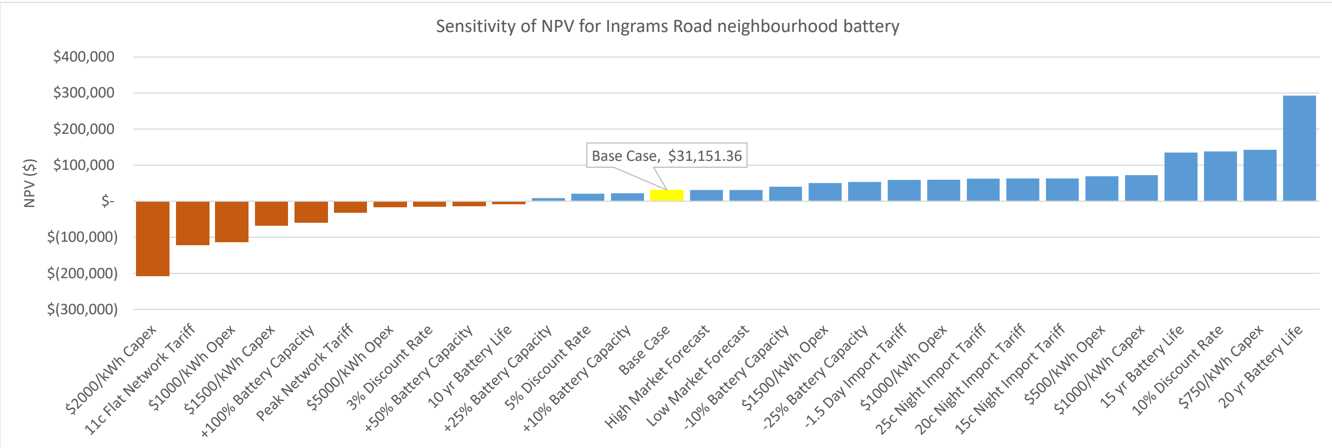


Figure 32. Sensitivity of feasibility (as measured by NPV) for Ingrams Road neighbourhood battery

In assessing the sensitivity of the Ingrams Road battery for the 30 scenarios, we find that the majority of the scenarios deliver a positive NPV.

The extension of the battery life, reduction in capex of the battery, and the reduction in operating costs, are the three main factors that are important in improving the financial feasibility off the projects.

The capital of the battery could be reduced by:

- sourcing products from a production line, rather than a custom new build,
- by locating the battery in very close proximity to a pole for connection,
- by reducing the need for air conditioning,
- by locating the battery in an area with less noise restrictions and therefore cost to mitigate noise.

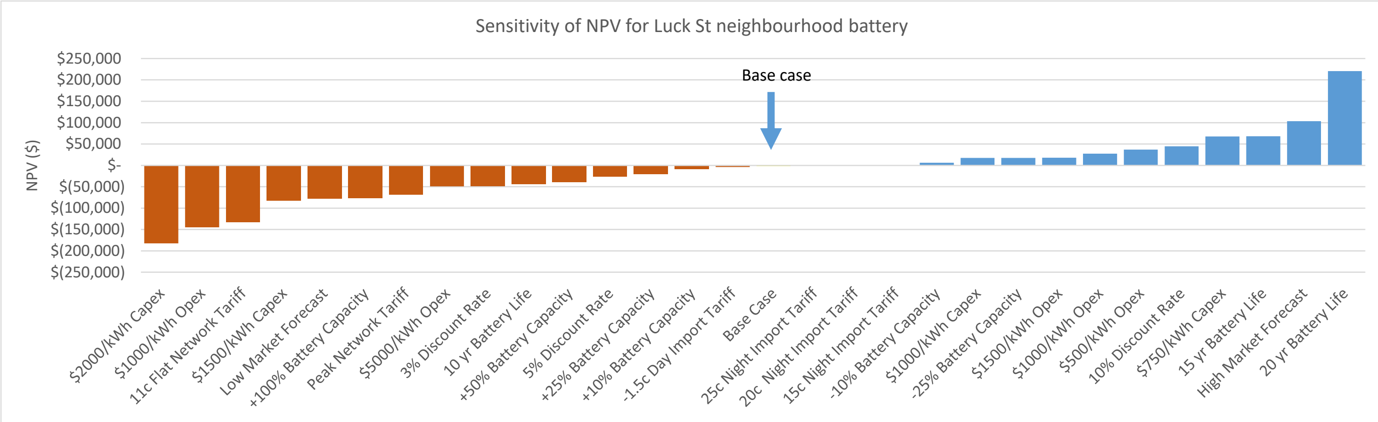


Figure 33. *Sensitivity of feasibility (as measured by NPV) for Luck St neighbourhood battery*

The Luck St base case has a positive NPV, and the modelling of scenarios show that the results are equally positive and negative.

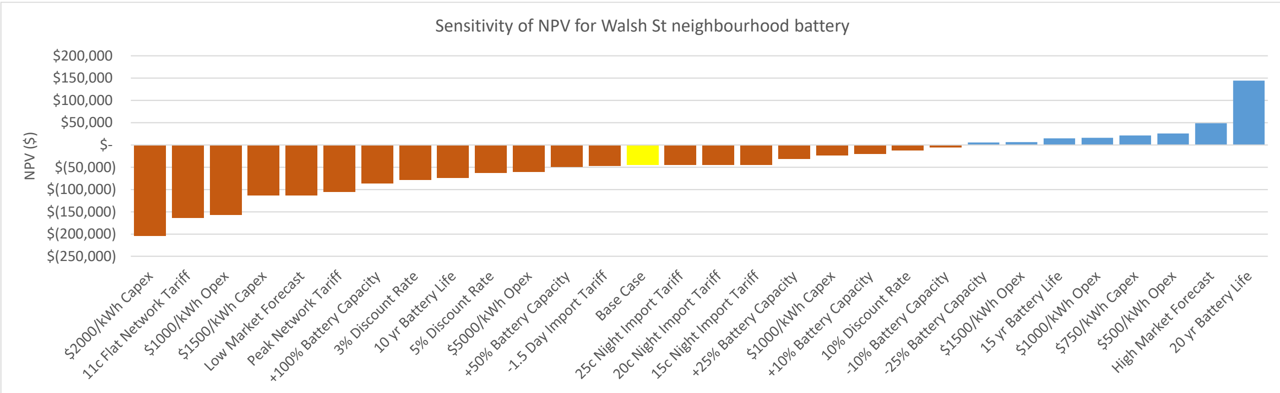


Figure 34. *Sensitivity of feasibility (as measured by NPV) for Walsh St neighbourhood battery*

The base case for the Walsh St neighbourhood battery was negative, and most scenarios show that the feasibility remains negative. Only a substantial change to the forecast wholesale and FCAC prices, battery life span and reduced operating costs will see this project become financially feasible.

6 Ownership

The location, community and customer support, sizing, connection status, financial returns, risk management, and town planning, are all irrelevant if there is no clarity or direction on the nature of ownership and ongoing management or operation of the asset. It is also difficult to get clarity on the location and connection to the network, without a decision on who the proponent is for this battery application.

One of the many objectives of this project was to consider how to identify and adopt an ownership model that puts the community at the heart of the venture. A report on community investment by Beckon et al (2019) on “Community Investment Funds. A How-To Guide for Building Local Wealth, Equity, and Justice” noted that “Capital is a critical tool for community problem-solving”[7], but need mechanisms to enable this to happen.

The terms ‘Impact Investments’ and ‘Community Investment Funds’ are emerging in the financial sector, but in Australia there is no special ownership or legal structure for these two terms. They must use the traditional company structure, unit trusts, incorporated associations, or cooperatives to establish and operate these investments.

In this section we outline the options for who could own neighbourhood batteries, both here in Nillumbik and beyond.

It should be noted that throughout the engagement process the team was clear that the objective was to create opportunities for the community to own OR to be a customer from the neighbourhood battery, but interestingly most indicated they would like to be both an owner and customer.

6.1 Possible ownership models

No.	Option	Description	Battery owned by	Battery operated by	Advantages	Disadvantages
1.	Retailer and DNSP model	Battery is owned and operated by the network support, to increase hosting capacity and leased to a licenced energy retailer, which will develop a specific offer for the households of Nillumbik.	DNSP	Retailer	DNSP can manage sizing and connection, and retail benefits flow from retail arrangement.	No role for community in ownership. DNSP must rely on a retailer as DNSP cannot operate in energy market and community objective not met.
2.	Government ownership	Owned by Local or State Government, and leased to a licenced energy retailer, which will develop a specific offer for the households of Nillumbik.	Local or State Govt	Retailer	Stability, governance, and insurance capacity. Local government could claim to then be more actively supporting climate action.	Not as nimble in responding to community. Resources would need to be dedicated to the administration and community liaison.

[7] Beckon et al, 2020. Community Investment Funds; A How-To Guide for Building Local Wealth, Equity, and Justice

No.	Option	Description	Battery owned by	Battery operated by	Advantages	Disadvantages
3.	Company with community shareholders	CEN to set up (with partners and govt support) a new company that would offer shares in batteries.	Community (as NFP)	Retailer	Local community at heart of venture.	New share offering required for each new battery. Max 50 shareholders before company must be publicly listed.
4.	Company with community shareholders administered by community bank or power hub	Community bank (or regional Community Power Hub) acts as secretariat for company and provides administrative support.	Community (as NFP)	Retailer	Community bank has capacity and skills for administration of company. Community Power Hub do not have the same financial capacity but do have a clear alignment with community energy projects.	Max 50 shareholders before company must be publicly listed.
5.	Unit trust	A unit trust is a common business structure where the business is a venture between several unrelated interests. Beneficiaries have a fixed interest in all the property that is the subject of the trust.	Community (Company)	Retailer	The main advantages[8] of a unit trust are that it provides unitholders with a fixed entitlement to income and is eligible for the 50% CGT discount.	Will be difficult to add more unitholders for separate battery investments.
6.	Managed fund with a managed investment scheme.	This option allows for one company to manage several investments and allow for unlimited members. Managed investments schemes are a special type of structure within the Corporations Act, whereby one company can manage a diversity of investments in several asset types. CEN or another entity could set this up.	Manged fund	Retailer	Can scale with new batteries and is especially designed to develop specific investments for different members.	Must have a financial services licence. Set up fees and disclosure rules must be taken account of.

[8] LegalVision, 2020. What is the Difference Between a Unit Trust and a Company? Accessed at https://legalvision.com.au/difference-between-a-unit-trust-and-a-company/

No.	Option	Description	Battery owned by	Battery operated by	Advantages	Disadvantages
7.	Cooperative	Cooperative organisation with a board and members, which would own and oversee operation of the asset.	Community (Coop)	Retailer	Strong grass roots and community structure to it.	Requires dedicated local community and board with capacity and governance skills. Does not easily allow for external investors.

6.2 Preferred model: Managed investment scheme

Option 6 is the preferred option, due to the fact that it is a mechanism that has the ability to scale and allow for community members and other investors to buy into local neighbourhood batteries as well as other renewable assets over time.

A managed investment scheme is the term used in the Corporations Act and by ASIC but is also known as a managed fund. According to ASIC[9], to register a managed investment scheme, the proposed responsible entity must:

- be a registered Australian public company
- hold an Australian financial services (AFS) licence authorising the responsible entity to:
    - operate the scheme (either an 'in-kind' scheme authorisation or 'named-scheme' authorisation)
    - provide any other relevant financial services in relation to the scheme and its underlying assets.

A managed fund would be the umbrella company. A conceptual diagram is shown below (to capture the key elements of this structure.

The preferred model would be to engage with various stakeholders across the state, and ideally with the use of seed funding, consider how and who is best placed to set up this structure. Ideally CEN would not need to establish this type of ownership structure, as it could be used across a wider area (whole city, state, or country) and be used well beyond Nillumbik.

The main problem to overcome with this ownership structure is the initial setup, and then managing the assets to reduce the need for administration in the form of public disclosure statements.

Another key issue for consideration that may arise is the status of the investors in the managed fund. There are 'sophisticated investors' and retail investors. ASIC[10] states that the Corporations Regulations prescribe the asset and income criteria which must be met before you can issue a certificate (which is relevant to the definition of a sophisticated investor). A person is only eligible to be the subject of a certificate if they have:

- a gross income of $250,000 or more per annum in each of the previous two years or
- net assets of at least $2.5 million (reg 6D.2.03 and reg 7.1.28).

[9] ASIC, 2022. How to register a managed investment scheme. Accessed at https://asic.gov.au/for-finance-professionals/fund-operators/how-to-register-a-managed-investment-scheme/

[10] ASIC, 2014. Certificates issued by a qualified accountant. Accessed at https://asic.gov.au/regulatory-resources/financial-services/financial-product-disclosure/certificates-issued-by-a-qualified-accountant/

ASIC states that "The rationale is that people meeting one of these criteria are more likely to be able to evaluate offers of securities and some financial products (such as interests in managed investment schemes) without needing the protections of a regulated disclosure document."

These issues of individual circumstances and tax implications of the investment would need to be considered for each individual that is interesting in becoming an owner of the neighbourhood battery.

Conceptually the managed fund has been outlined in the figure below.

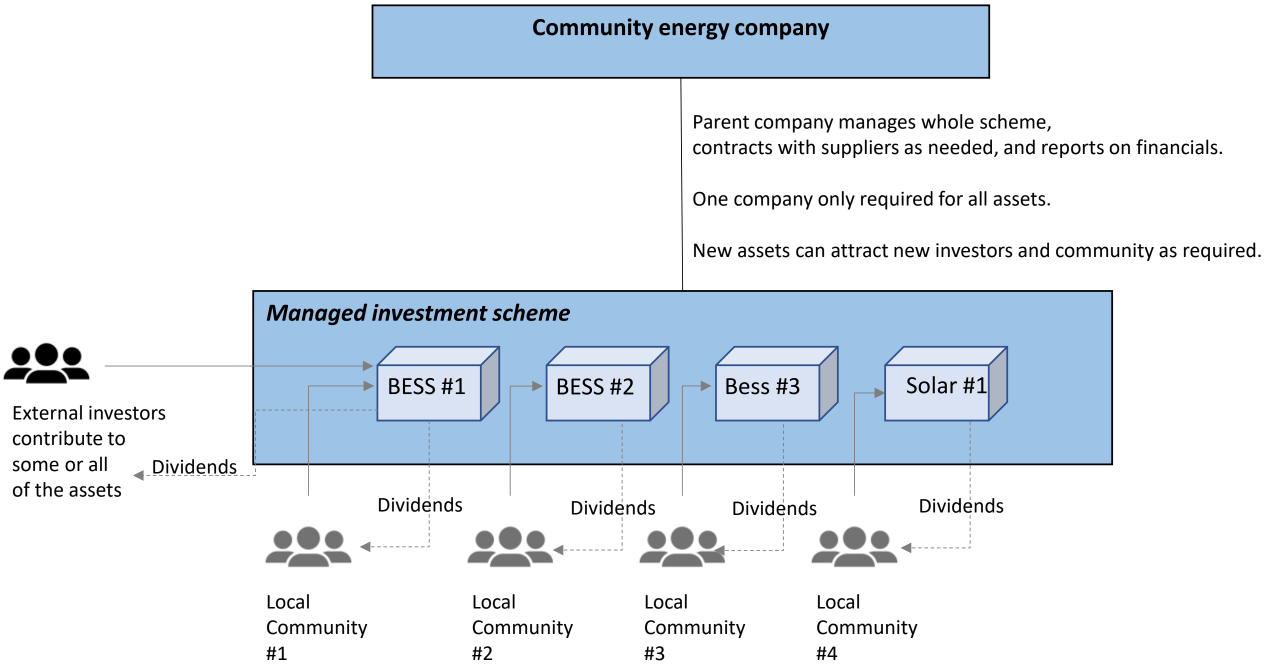


Figure 35. Managed fund ownership structure for neighbourhood batteries and other assets

While a company structure (Option 3 and Option 4) is used often across the country for all sorts of investments and can be set up to enable community / householders to be shareholders, a new company for each asset is required under this model. Also under the Corporations Act, a company is classified as proprietary (meaning a private company) only for so long as it has no more than 50 non-employee shareholders. So, a neighbourhood battery that involves more than 50 households or small businesses, or additional investors, would need to consider the administration and disclosure requirements of running a public company.

Option 3 and Option 4 are easier structures in the short term but may be harder in the longer term.

Lastly, Option 2 (Council owned) should not be ruled out as it would benefit from the fact that the Council has significant capacity in terms of its administrative structure and financial stability, to host and set up a new entity for this specific investment and operational purpose. Under Option 2, the community would benefit directly through the ability to engage with the battery through an energy retailer but would not technically own this asset. The Council could support this ownership option on the basis that the battery would a) make money, and b) support the community in transitioning to more renewable energy and is consistent with council's climate strategy.

To fast track the development of a community owned battery, Option 2 (Council or DELWP owned) could be used to trial the first of these projects, on the basis that the this will enable a more efficient start up process and secure funding and administration to commence the first battery project.

It should be noted that the cost of the setup of a new ownership structure is not included in the financial analysis above, which must be factored into any future business case to seek investment or further grant funding.

7 Who benefits?

There are a range of benefits from the delivery of a neighbourhood battery, starting very locally in the specific households within the three priority zones, to the wider community, and the whole electricity market and grid.

7.1 Community within LV network

The presence of a neighbourhood battery in each of these LV network zones (see Figure 7, Figure 9 and Figure 11 for these locations) is specifically aimed at helping this community, and communities in this region.

A neighbourhood battery would reduce the exporting of solar energy to near zero and reduce the negative power flows at the transformer to near zero kVA.

The community would have a more stable grid and be more likely to have a grid that could support more solar installations, more energy efficiency, and more electric vehicles. It would be best placed to test options to create island (or resilient grids that keep the power on while the grid is without power).

The neighbourhood batteries in this region could retail at between 25 and 30 cents / kWh, but a retailer is needed to confirm this price structure.

Customers who sign up to the designated retailer would be effectively consuming locally produced solar power, that is stored in this neighbourhood battery, and discharged to residents that night.

7.2 Nillumbik community

Based on the community engagement completed in this project, there is a high level of interest across Nillumbik. The Nillumbik community would benefit in two ways from these neighbourhood batteries.

Firstly, they could also become customers (and investors) in these batteries, despite not living within the three zones of interest. Secondly, they will benefit through the fact that these projects will act as a trial and pave the way for a series of neighbourhood batteries in the region.

The fact that there are now nearly 20 ‘community champions’ that emerged through this project provides a lot of confidence that there is the capacity and willingness to grow this concept from three trial sites to many more across the region.

7.3 Customers with and without solar

An objective of this project was to create a model for all households to have access to a battery, not just those that can afford the upfront investment, or those that have existing solar panels at home.

The benefits of this battery are set up to flow to any residents in these areas, not just those that already have solar. This benefit is supported through the adoption of a flexible ownership model.

Through a partnership with a retailer (a necessary requirement to ensure the batteries can participate on the FCAS market), renters and owners of property can be engaged in this project and benefit from the purchasing of energy supplied by the battery. When the battery does not have any charge, the retailer would source and buy other power to supply the gap to the respective residents.

It should be noted that there are some in the community who have solar, but are also very energy efficient, and may not see a lot of value as a customer as their power needs as so low.

7.4 DNSP benefits

The section above on revenue streams (Section 5) noted that the DNSP would benefit through the influence on power flows in the network and address the trend of increasing negative power flows through the transformer.

The DNSP will also benefit through network services, which is NOT accounted for in the above technical and financial modelling.

What should not be underestimated is the innovation opportunity, and reputational benefit of supporting this type of project, noting through this project the project team identified that the community have a large expectation that the DNSP should be supporting this smart transition of the grid, and value the stability and resilience of the grid.

The DNSP would benefit in the long term through the deferral of network augmentations, but to be clear this particular benefit was not modelled or forecast in this project.

7.5 Value to local council

From a council perspective the installation of a neighbourhood battery could be seen to add value through a few different avenues. Firstly, it would be tangible and locally specific action that would be consistent with taking action to address the climate emergency and support the implementation of the Council's climate action strategy. Secondly it would be seen as a playing a supporting role in improving the liveability of the residents, through a more stable and resilient grid.

There is an option for the Council to take on a leadership role here and get more value from these installations and add some financial support to the delivery of neighbourhood batteries, by taking ownership of this infrastructure (on the basis that it is a cost neutral or profitable venture for Council).

Lastly it should also be acknowledged that the Council needs to also consider the impact on land use and appropriate use of open space, and if a neighbourhood battery is seen to compromise that value, then Council would no doubt see this asset as less than desirable for the local region.

7.6 Building social capital and a story of innovation and resilience

The conversations, feedback, interest, and support for this project suggests that this project could become a catalyst and community building exercise for the community. People are looking to act on climate change, and become more energy independent, and there is interest in action at the household, street, suburb, and whole city scale.

The community are not necessarily interested in just one battery, but interested in a range of actions, and see a battery as a way to accelerate a move to a zero emissions grid, but in particular a smarter and renewable grid.

The simple act of gathering community members on the street corner immediately builds connections and builds a small degree of social capital that can be continually enhanced through this project and then the next one.

This project is very specific in its focus on neighbourhood batteries, but it could actually deliver a lot in terms of building social capital and supporting communities.

8 Next steps and recommendations

To move these three neighbourhood battery projects forward, there are four main issues to resolve: ownership structure and administration, financial investment and expected returns, AusNet tariffs, and agreements with landowners. All of these issues have progressed in this project but need additional work or decisions to ensure the project can move ahead.

More specifically there are several steps to move from this stage of feasibility, to an on the ground project. These include (in order of priority):

1. Review the feasibility report and use the 'community champions' to review and refine these next steps to develop a clear pathway and timeline from feasibility to operation.
2. CEN to discuss governance structure. A significant decision to enable the project to proceed is how the whole venture should be structured and governed, and who owns this venture and how the community can be active investors in future neighbourhood batteries (and other renewable energy / community energy assets). An important step here is a discussion with various stakeholders, including the local community bank, the Community Power Hub, Council and AusNet Services, to determine the level of interest and support that each can provide. Also, a discussion with the Mayor and Executive of Council should be undertaken to discuss options for council support or ownership.
3. Confirm future community battery tariff structure. CitiPower have introduced a trial tariff and further work from AusNet Services will hopefully see a similar tariff structure trialled in the AusNet Services area, to commence on 1 July 2023.
4. Confirm and review detailed cost estimates, based on AusNet Services advice on connection requirements and background studies required.
5. Review and consider other sites based on input from AusNet Services. An important step going forward is to explicitly investigate other sites, particularly noting that the Walsh St battery is less feasible than the other two sites.
6. Confirm site location with landowners. While some initial due diligence has been completed, with the preferred sites of interest, it is important to continue that engagement and ideally secure a formal letter of support or lease agreement, to proceed with capital raising and connection applications.
7. Confirm detail and data required for connection (and associated network studies). With the initial information available, and the original site selection, AusNet Services have indicated that these sites can have neighbourhood batteries augmented into the local voltage network. AusNet Services are required to formally document what is required to proceed with a connection application.
8. Consider options for grant applications to de-risk the venture. The result from this feasibility study is that most scenarios have a positive net present value for two of the sites, but the start-up process and the finalisation of some of the detail for these pilot batteries would require some seed or grant funding.
9. EOI with energy retailers. Prior to sending out any 'offers' to the community the project team must first consider which retailer is best placed to deliver the retail offering and battery management.
10. EOI for the community. An expression of interest should be undertaken to clearly outline the options for members of the community. It is expected that there will be two types of offers, one for those in the immediate low voltage networks, and one for those just outside that network zone.
11. Contract with energy retailers.
12. Capital raise. Once the ownership, land agreements, connections and energy retail arrangements are in place, then the Nillumbik Neighbourhood Battery group would be able to best understand how much capital, from how many residents and how many other investment supporters are required.
13. Commencement of tendering and construction process. The final step is to then proceed into project delivery mode and commissioning. There are other projects that the NBI has funded (e.g., North

Fitzroy, Tarneit, and Phillip Island) that will be useful in learning from prior to commencing this part of the project.

The figure below presents an ideal timeline to enable up to three neighbourhood batteries to be delivered over the next 18 months. This figure captures the various issues that need to be addressed in the coming months to move this project through to reality.

CEN should prioritise resources to focus on working with AusNet on a community battery tariff trial, and land ownership / lease arrangements, noting several tasks need to be completed in parallel.

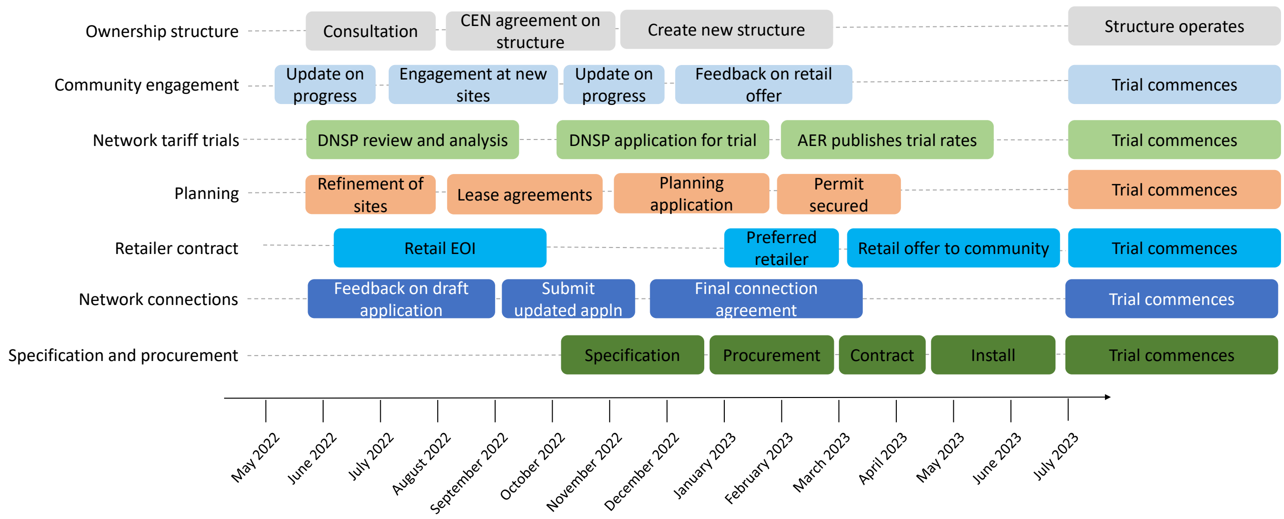


Figure 36. Next steps and possible timeline for implementation of a neighbourhood battery in July 2023.

9 Lessons for future neighbourhood batteries

There are several lessons to be learnt from this feasibility study and the issues that need to be addressed in proposing and building a neighbourhood battery. In this chapter the main issues encountered over the course of this project are summarised. These are presented below in order of the scale and impact that these issues have had on the project, and therefore the lesson for future neighbourhood battery projects is to address these and plan for these early in the process.

Data availability. A significant issue that had a large impact on the efficiency and accuracy of the project was influenced by the availability of aggregated data of current electricity power usage and solar exports, and the number and scale of solar and battery installations in the zones of interest. Another data related question that arose a lot in this project was the suitability of the sites in the first place, but without additional network data this was impossible to assess.

Tariff waivers and trials. The process to develop and trial new electricity network tariffs is complex, and DNSPs manage such a large network of infrastructure, and have such a large turnover, that it was difficult to even discuss the prospect of a community battery tariff trial in Nillumbik. The lesson is to engage early with these teams within the DNSP and consider what other options there are for community projects to access trial tariff rates or at least more easily discuss options.

Ownership. A key issue to progress many of the options and models for neighbourhood batteries is answering the question “who is proposing this?” Having a clear idea or ideally an established entity that can be the lead proponent will ensure that discussions regarding land agreements, connection agreements, and engagement with the community can be clearly led by the single entity and provide more certainty to the discussion.

DNSP engagement and financial stake. For this project the DNSP did not have a financial stake in the project, or it seems any significant interest in the outcome of the project, so it just was not a priority for the organisation. In hindsight if the DNSP was a financial partner in the project, the project team assumes that there would have been a greater level of engagement and access to data throughout the project.

Site identification and land ownership. While the areas of interest (the specific local voltage network) were already identified, in terms of identifying a specific site the lesson is that this is relatively hard without access to land titles data. From a community perspective, the project team found that the community has very little concern about a neighbourhood battery that was approximately equivalent to the size of a shed, somewhere in their streetscape environment.

Council resourcing. Council was supportive of the project, at various levels, but a lesson from this project is that much more resourcing is required to support a project like this. There was a three-month period of delay in waiting for engagement from Council planners. The lesson here is to get senior Councillor support first, and then ideally have executive support for the project that results in resources allocated to the project, to enable a more comprehensive and more efficient engagement process with Council.

Community interest in batteries as power back up. Interestingly the community had a clear and consistent expectation that the most value the neighbourhood battery could provide would to ‘island’ their area of the network. A lesson here is to either better explain why this is hard, or to accelerate projects to create microgrids that can be islanded for up to 24 hours and increase the resilience of the network and keep the power on for residents and small business. Managing the expectation is the main lesson from this project.

DNSP community engagement forum. One possible solution to improving the link between community energy projects and the regulated network and emerging markets areas of the DNSP, is to set up a group made up of DNSP representatives and also community / industry representatives, to enable the DNSP to better appreciate the needs, wants and vision that the community has.

Saving money was not the most important issue. Saving money was very rarely raised as a core objective of a resident. Obviously, people did not want their energy bills to be increasing, but there was far more willingness to explore how this would work and recognise other benefits to having a neighbourhood battery within their local network.

Neighbourhood batteries, verses garage and electric vehicles. From a community perspective, the project team found that when we raised the prospect of a neighbourhood battery, the community saw this concept as an option they would weigh up alongside buying their own battery, and also in the same conversation as buying an electric vehicle. It broadly fits into a conversation and investment in 'future smart electricity options' from a community perspective and being able to explain neighbourhood batteries in the context of EVs and home batteries is important.

Managing community expectations. One issue that arose was the fact that the community were expecting something (i.e., a neighbourhood battery) to be installed in the near term (i.e., this year or in a few months), not in several years. There is an appetite for works like this, but there is a problem in meeting that expectation.

A vision for community action. Related to the point above on managing community expectation, a lesson from this project is that there is an appetite for action, innovation, and a willingness to be involved in a new type of smart grid that benefits all in the community, but residents and community need a leader, and they need a project to enable them to build on. This neighbourhood battery could be that project that becomes a catalyst for change at a number of levels.

Fire and noise not an issue. The project team was surprised to find that the fire risks and noise issues were very rarely raised as issues regarding the location or overall suitability of neighbourhood batteries.

10 Conclusions

Neighbourhood batteries are feasible at two of three locations analysed in this study in Nillumbik. The capital required for these two batteries is around $510,000.

The Ingrams Road site modelling results show it to clearly have a positive NPV. The modelling of the Luck St site shows it to have a very small negative NPV, but the conclusion is to proceed with this option. This recommendation is based on the fact that this location is very close to the transformer, so has several opportunities to reduce the capital costs, and also on the basis that over a 10 to 15 year period it is expected that other revenue sources (such as demand management, charging of electric vehicles) would emerge and enable this project to realise a positive NPV.

There is real benefit in moving ahead with a trial of two batteries over one site, and some efficiencies in delivering two battery projects, not one.

Ideally CEN would seek $750,000 of grant or seed funding to set up a new entity and deliver these two batteries. This would enable all stakeholders to develop a working model, and then future projects would seek community investment.

The feasibility is heavily influenced by some key factors and parameters, such as the cost of the batteries, the operating cost of the battery, the life cycle of the battery, network tariffs, and forecast revenues.

The Net Present Value of two of the most feasible sites are between $0 and $35,000 over a 12.5-year period. Without the adoption of a 'Community Battery Tariff' this would drop by between $40,000 and $120,000.

The community engagement has indicated there is significant support for these projects, and beyond the current proposal the community in fact have explicitly stated they want these neighbourhood batteries to do more than just energy arbitrage and FCAS trading, and ideally want to see these batteries to support grid back up and islanding of these small LV networks.

The community are interested in owning or using the neighbourhood batteries on the basis that they are part of an integrated approach to smarter energy use, allow for an increase in the generation of more locally produced renewable energy, support the adoption of more electric vehicles, and a move to zero emissions communities and economies.

There are several ownership options that vary in complexity and also in terms of the long-term potential to administer and support community ownership of these assets. This project has recommended a managed investment scheme to enable community and investor ownership, and to avoid the need for a new company for each individual battery.

The specific local voltage networks sites investigated in this study have a range of issues, but on the whole meet the main criteria as appropriate sites for neighbourhood batteries. The key barrier to overcome is the land ownership and associated leasing arrangements at each site.

The feasibility study has been affected by the ability to get timely access to data, particularly DNSP related datasets. This is an issue the industry is addressing and needs to continue to work on to more efficiently assess the feasibility of neighbourhood batteries.

The role of the DNSP and Council in this process is critical, as is access to good data and market data on costs. The process of feasibility studies could be significantly improved through timely access to data, and increased resourcing to engage and respond to issues as they arise. If the stakeholders made a financial contribution to the feasibility study, it is assumed they would be more likely to support and assist the project.

The feasibility study outlines a pathway and series of next steps, including:

1. Review the feasibility report.
2. CEN to discuss governance structure.
3. Seek grant funding
4. Consider options for grant applications to de-risk the venture.
5. Review other sites to ensure these battery locations are the best in the region.
6. Confirm site location with landowners and obtain lease agreements.
7. Confirm connection arrangements.
8. Confirm future community battery tariff structure
9. EOI with energy retailers.
10. EOI for the community.
11. Contract with energy retailers.
12. Capital raise.
13. Commencement of tendering and construction process.

11 References

AECOM, 2019. Grid vs Garage. A comparison of battery deployment models in providing low voltage network support and other services. A report for ARENA.

AER, 2022. CitiPower Trial tariff notification 2022-23. Available at https://www.aer.gov.au/system/files/CitiPower%20-%20Tariff%20trial%20notification%20-%202022-23_1.pdf

ASIC, 2014. Certificates issued by a qualified accountant. Accessed at https://asic.gov.au/regulatory-resources/financial-services/financial-product-disclosure/certificates-issued-by-a-qualified-accountant/

ASIC, 2022. How to register a managed investment scheme. Accessed at https://asic.gov.au/for-finance-professionals/fund-operators/how-to-register-a-managed-investment-scheme/

Ausgrid, 2020. Community batteries. Accessed at https://www.ausgrid.com.au/In-your-community/Community-Batteries

AusNet Services, 2022. Per comms. Informal conversation re PV installed capacity.

Beckon et al, 2020. Community Investment Funds; A How-To Guide for Building Local Wealth, Equity, and Justice

DELWP, 2019. RENEWABLE ENERGY FACILITY (OTHER THAN WIND ENERGY FACILITY). Accessed at https://planning-schemes.api.delwp.vic.gov.au/schemes/vpps/53_13.pdf

Dyson, J., 2017. Let's talk about FCAS. Published on Wattclarity.com.

LegalVision, 2020. What is the Difference Between a Unit Trust and a Company? Accessed at https://legalvision.com.au/difference-between-a-unit-trust-and-a-company/

Nillumbik Shire Council, 2021. Significant Landscape Overlay. Accessed at https://www.nillumbik.vic.gov.au/Develop/Planning/Planning-advice-and-checklists/Significant-landscape-overlay

Ma, L., Chen, R., Hu, Y., Zhang, W., Zhu, G., Zhao, P., et al. (2018). Nanoporous and lyophilic battery separator from regenerated eggshell membrane with effective suppression of dendritic lithium growth. Energy Storage Mater. 14, 258–266. doi: 10.1016/j.ensm.2018.04.016

12 Appendix A. Tariffs

The tariffs in the AusNet Services Tariff Structure Statement 2021-2026 are traditionally used to assess the costs and revenue for energy arbitrage.

Current tariffs that most customers in these zones will be on are shown below.

Table 8. Tariffs from AusNet Tariff Structure Statement

Tariff class	Tariff	Description	Charging parameter	FY2022
Residential	NEE11	Small single rate	Standing charge ($/year)	111.7400
			Block 1 (c/kWh)	11.7596
			Block 2 (c/kWh)	13.1840
	NAST11	Small residential time of use	Standing charge ($/year)	111.7400
			Peak (c/kWh)	20.1490
			Off peak (c/kWh)	4.2459
	NAST11S	Small residential time of use standard feed in	Standing charge ($/year)	111.7400
			Peak (c/kWh)	20.1490
			Off peak (c/kWh)	4.2459
Small business	NEE12	Small single rate	Standing charge ($/year)	111.7400
			Block 1 (c/kWh)	15.4950
			Block 2 (c/kWh)	18.1977
	NAST12	Small business time of use	Standing charge ($/year)	111.7400
			Peak (c/kWh)	18.9812
			Off peak (c/kWh)	4.3300

These tariffs include the NUoS (the network use of service). There are no tariffs in the Tariff Structure Statement that refer to rates for a Local Use of Service (LUoS) or a Community Battery Trial. The project team modelled a 'conceptual LUoS tariff' to better understand the impact on the feasibility study with that tariff rate. ANU have suggested a LUoS should be set at 50% of the NUoS.

Modelling used the recently published tariff trials by the Australian Energy Regulator statement on CitiPower Trial tariff notification 2022-23[11] that includes a reference to 'Non-distributor owned community battery' tariffs.

A non-distributor owned community battery will incur the following trial tariff network charges which exclude GST.

Time band	Fixed (cents/day)	Import rate (cents/kWh)	Export rate (cents/kWh)
10am – 3pm	45	-1.5	0
4pm – 9pm		25	-1.0[1]
All other times		0	0

All times are in local time
Same rates apply every day of the year
A positive rate is a charge, and a negative rate is a rebate

A community battery that is assigned to this tariff will remain on this tariff until 30 June 2026.

If a revised community battery tariff is introduced, then this tariff will be closed to new community batteries.

[11] AER, 2022. CitiPower Trial tariff notification 2022-23. Available at https://www.aer.gov.au/system/files/CitiPower%20-%20Tariff%20trial%20notification%20-%202022-23_1.pdf

13 Appendix B. Modelling

For every interval, each scenario presents revenue from all three streams:

1. FCAS: this revenue is expected to fall with the commissioning of new batteries in the 2020s, different rates have been considered and can be observed in Figure 37. Since the battery is not always full, it won't obtain revenue for 100% of its available capacity.

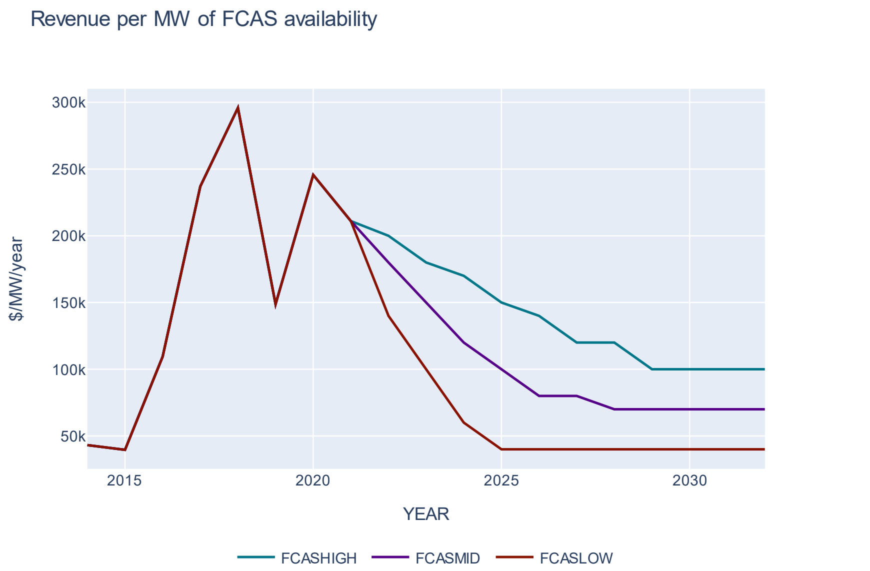


Figure 37. Historic and predicted FCAS prices in Victoria (YEF)

2. Wholesale prices:
   a. Arbitrage: small revenue of low volatility gained with day-to-day charging and discharging
   b. Peak prices: volatile but large revenue dependent mostly on coal station closures. The number of hours and value of these will determine the peak revenue.

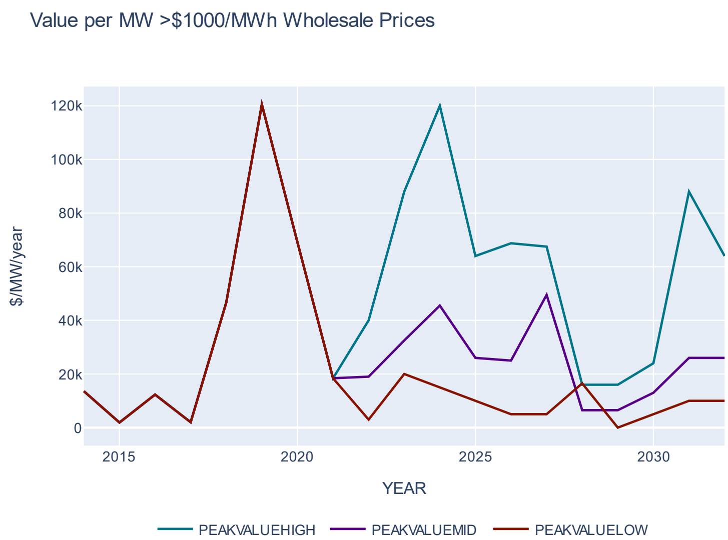


Figure 38. Historic and predicted value of peak prices in Victoria (YEF)

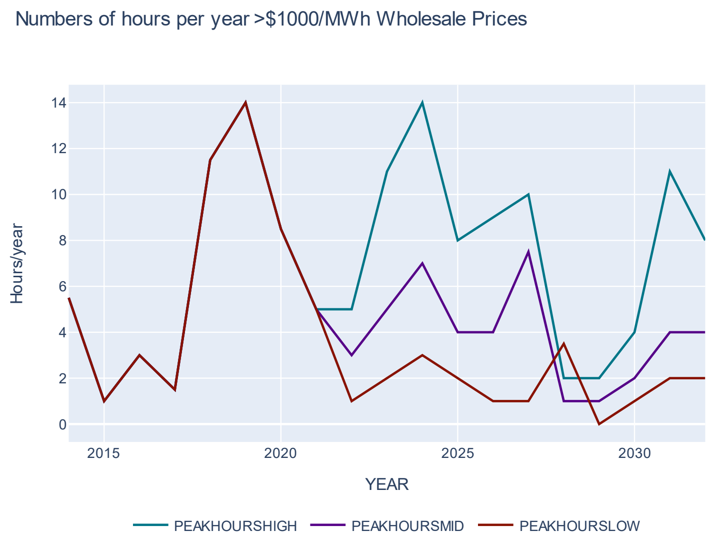


Figure 39. Historic and predicted hours of peak prices in Victoria (YEF)

3. Network: based on the trail CitiPower tariffs for neighbourhood batteries, plus the increased cost of using the Ausnet network. It provides an incentive to arbitrage between high and low daily demand.

Table 9. Network tariffs.

Time band	Fixed (cents/day)	Import rate (cents/kWh)	Export rate (cents/kWh)
10am – 3pm	45	-1.8	0
4pm – 9pm		40	-1.0
All other times		0	0

14 Appendix C. Draft connection applications

14.1 Ingrams Road

Location / address: Lot south of 35 Ingrams Road, Research.

Project Location Maps (ideally Google Earth files showing project location, boundaries, collector substation site etc):

NMI (if applicable): NA

Proponent: TBA

Battery specifications: 280 Capacity (kWh) & 125 Power (kW)

Type: Micro (< 200 kW, Non-registered 200kW to 5MW, > 5 MW registered): Micro

Connection point: Pole

SLD: To be determined with additional AusNet Services data

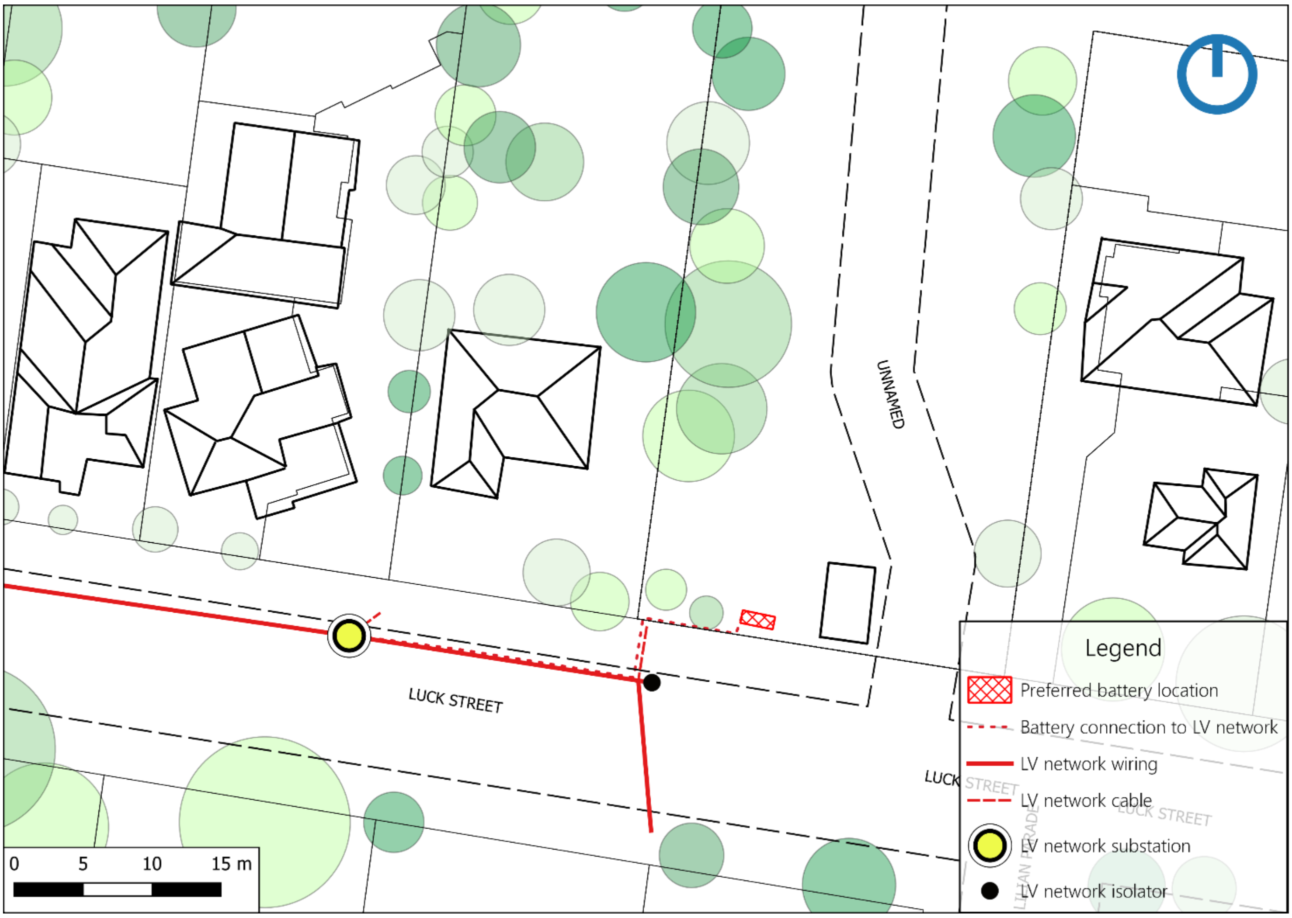
AMEO registered participant: Generator exempt status due to < 5 MW[12]

14.2 Luck Street

Location / address: 144 Bible St, Eltham VIC 3095 (but access from Luck St)

[12] AEMO, 2022. Guide To Generator Exemptions And Classification Of Generating Units.

Project Location Maps (ideally Google Earth files showing project location, boundaries, collector substation site etc):



NMI (if applicable): NA

Proponent: TBA

Battery specifications: 200 Capacity (kWh) & 90 Power (kW)

Type: Micro (< 200 kW, Non-registered 200kW to 5MW, > 5 MW registered): Micro

Connection point: Pole

SLD: To be determined with additional AusNet Services data

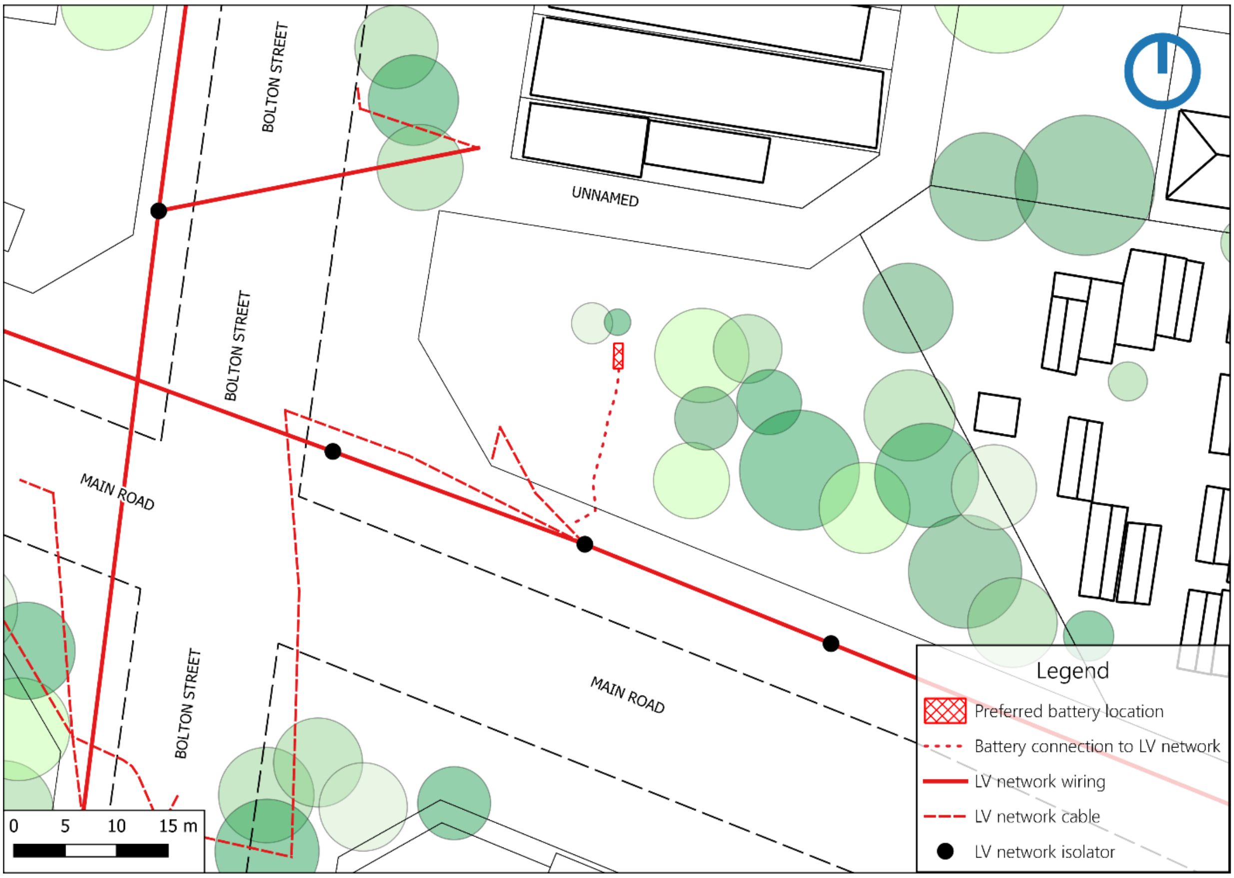
AMEO registered participant: Generator exempt status due to < 5 MW[13]

14.3 Walsh Street

Location / address:

Project Location Maps (ideally Google Earth files showing project location, boundaries, collector substation site etc):

[13] AEMO, 2022. Guide To Generator Exemptions And Classification Of Generating Units.



NMI (if applicable): NA

Proponent: TBA

Battery specifications: 180 Capacity (kWh) & 80 Power (kW)

Type: Micro (< 200 kW, Non-registered 200kW to 5MW, > 5 MW registered): Micro

Connection point: Pole

SLD: To be determined with additional AusNet Services data

AMEO registered participant: Generator exempt status due to < 5 MW[14]

[14] AEMO, 2022. Guide To Generator Exemptions And Classification Of Generating Units.

15 Appendix D. Clauses and Overlays

This appendix includes various clauses and overlay definitions as a reference.

General considerations

There will be a variety of issues to consider in locating and installing a neighbourhood battery. These include:

- **Neighbourhood character**: individually controlled containers with monitoring and fire suspension systems. No emissions or noticeable vibration. Emergency management plants for potential disturbances and hazards.
- **Noise:** locations vary from 10 to 50 m from residential properties, but all contain a sound wall or vegetation.
- **Aesthetics:** most large-scale batteries use purpose-built containers that can be painted, positioned, and screened effectively for minimal visual impact (Vic Gov).
- **Access:** may interrupt walking or cycling pathway. May need access for garden maintenance to walk through. Also need to consider access to the battery for maintenance.
- **Transport:** visual obstruction of roads or obstruction of walking or cycling ways.
- **Energy Safe Victoria's Safety Standards** for High Voltage and Complex electrical installations. From a connection perspective there is a different process if the battery has a capacity of 1 MW or more, then it becomes known as a 'complex electrical installation' under the Energy Safe Victoria's Safety standards for High Voltage and Complex electrical installations. Specifically, it states that:

  "Complex electrical installation means an electrical installation that:

  (a) has an installed generation capacity of equal to or greater than 1000 kVA (kVA x power factor/electrical efficiency = kW); or

  (b) is an electric line that is on land that is not owned or leased by the owner or operator of the electric line".

  From Victoria's Safety Standards the neighbourhood battery must comply with:

- Electrical equipment may not be installed on premises occupied if considered unsafe.
- Serious accidents must be reported.
- Comply with the safety standards:
  - No electrical current leaks.
  - Installed and maintained every 2 years by competent qualified authorised personnel. Training according to the Blue Book.
  - Methods of operation, maintenance, earthing, isolation, energisation, and de-energisation must be specified.

Section 86 of the Electricity Industry Act 2000 (Vic) Power to Acquire easements with approval of Governor in Council

Section 86 of the Electricity Industry Act 2000 is most likely beyond the scope of this concept of a neighbourhood battery, and more relevant for DNSPs and their role in managing the network of poles and wires.

Clauses 62.01 and 62.02. Uses not requiring a permit

Clause 62.01 and 62.02 of the Victorian Planning Provisions determine when a utility is working on the network and would be exempt from requiring permit.

A battery project may not require a permit as it is: "Use of land for a minor utility installation".

Clause 53.13. Renewable energy facility other than wind energy facility

Clause 53.13[15] of the Victorian Planning Provisions relates specifically to a renewable energy proposal. An application requires a site and context analysis of the location including facilities, surroundings, and a design response. The design response should detail the building development technical and aesthetic characteristics, any impact on the environment traffic or cultural heritage and a benefit suitability statement of the renewable energy facility.

The decision will be based on the impact on the surrounding area, significant views, natural environment and required traffic measures.

This clause would be particularly relevant to a solar farm, it makes no mention of battery storage systems.

Amendment VC192

Amendment VC192 – Energy Generation Facilities and Utility Installations makes the Minister responsible for all planning permit applications and project approvals for energy generation facilities of 1 MW or more throughout the state. This includes battery storage projects.

The 1 MW threshold is particularly important for a neighbourhood battery, as the battery may be less than this size and therefore not be subject to this amendment.

Clause 73.03. Land Use Terms

Clause 73.03 of the Victorian Planning Provisions relates to land use. In this context a battery installation is considered a "minor utility installation".

Clause 42.03. Significant Landscape Overlay

Clause 42.03 of the Victorian Planning Provisions relates to the classification of the region as having significant landscape. Much of the Shire of Nillumbik has a SLO.

A significant landscape overlay must contain "A statement of the nature and key elements of the landscape and the landscape character objective to be achieved".

The overlay requires a planning application for any proposal to construct a building, or carry out works, or a fence, or remove, destroy, or lop any vegetation.

In the context of a neighbourhood batteries and this landscape, it is definitely something that needs to be considered for potential neighbourhood batteries locations and proposals.

Clause 44.03. Flood overlay

---

[15] https://planning-schemes.api.delwp.vic.gov.au/schemes/vpps/53_13.pdf

Clause 44.03 of the Victorian Planning Provisions considers flooding and flow paths. If this overlay exists then a project must identify major flood paths, drainage depressions and hazardous areas with greatest risk of flooding to ensure development is compatible with local drainage conditions.

Clause 44.05. Special Building Overlay

Clause 44.05 of the Victorian Planning Provisions relates to the risk of flooding and overland flow paths. If a battery is located within this overlay, and involves a fence, a deck or land subdivision, then a permit is required.

Clauses 52.16 and 52.17. Native Vegetation Removal

Clause 44.05 of the Victorian Planning Provisions relates to removing native vegetation. A project requires a permit if it will involve the removal of native vegetation, including dead unless it is incorporated in the precinct vegetation plan. The application requires a plan to remove vegetation according to specified guidelines. This aims to minimise the impacts from removal of native biodiversity and/or provide offset for its destruction.

It is unlikely that a neighbourhood battery would trigger this clause. If it did involve the removal of native vegetation, then the project may fall under exception for 'Utility Installation': "native vegetation may be removed to the minimum extent necessary to maintain safety of a minor utility installation or behalf of a service provider to instal a minor utility in accordance with the written agreement of the Secretary to the Department of Environment, Land, Water and Planning (Part 2 of the Conservation, Forests and Lands Act 1987)".

Bushfires

Note that the sites of interest for Clean Energy Nillumbik did not include any areas within a Bushfire Management Overlay, but for other neighbourhood battery projects this issue of fire risk may be relevant.

Significant landscape (Nillumbik specific)

Shire of Nillumbik[16] have summarised all five schedules related to this overlay:

SLO1 – Significant Low Density Residential Landscape Areas

Some of the proposed sites include areas of natural landscape and topography value, including native Australian trees or valuable visual impact of vegetation cover.

This schedule aims to minimise impact of works on landscape and promote retention of Victorian vegetation and site natural characteristics.

A permit may not be required if battery cover does not exceed 15% when combined with existing buildings and no part of installation is closer than 5 metres to a side or rear boundary not abutting a road. A permit is required to remove Victorian vegetation, and exotic or Australian trees unless requirements of the schedule are met.

SLO2 - Bush and Semi-Bush Residential Areas

Many general residential and low-density residential areas of the Shire appear as natural bush settings and are characterised by dense understorey with more open bush-gardens around houses.

Buildings are often obscured from the street by topography or indigenous vegetation.

---

[16] Nillumbik Shire Council, 2021. Significant Landscape Overlay. Accessed at https://www.nillumbik.vic.gov.au/Develop/Planning/Planning-advice-and-checklists/Significant-landscape-overlay

This schedule ensures that buildings and works, access driveways and earthworks are sensitively sited to consider these characteristics and that native vegetation is restored and enhanced where necessary.

A permit is required to construct buildings and works (including any fence) unless the requirements of the schedule are met.

A permit is required to remove, destroy, or lop any native vegetation, unless the requirements of the schedule are met.

SLO3 - Bush Garden

Areas covered by SLO3 are characterised by mature native and indigenous trees planted in bush style gardens.

Dwellings in these areas are set among the trees and are sited to minimise disruption to the landform and vegetation.

A permit is not required to carry out buildings or works provided the building or works are more than 5 metres from the base of any substantial tree and no higher than 7.5 metres above natural ground level where a substantial tree is defined as vegetation with a circumference greater than 0.5 metres at one metre above ground level.

A permit is required to construct a front fence.

A permit is required to remove, destroy, or lop any substantial tree where a substantial tree is defined as vegetation with a circumference greater than 0.5 metres at one metre above ground level.

SLO4 - Garden Court

These areas are characterised by residential development set within predominantly native vegetation.

Large native trees dominate the skyline and are common in gardens and reserves.

A permit is not required to carry out buildings or works provided the building or works are more than 5 metres from the base of any substantial tree where a substantial tree is defined as vegetation with a circumference greater than 0.5 metres at one metre above ground level.

A permit is required to construct a front fence.

A permit is required to remove destroy or lop any substantial tree where a substantial tree is defined as vegetation with a circumference greater than 0.5 metres at one metre above ground level.

SLO5 - Eltham Central

This schedule takes in the residential areas close to the Eltham central business area.

These areas are characterised by frequent native and indigenous high canopy trees and the siting of any residential development is within these trees.

A permit is required to remove destroy or lop any substantial tree where a substantial tree is defined as vegetation with a circumference greater than 0.5 metres at one metre above ground level.

A permit is not required to construct a building or carry out works.